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Castings Used in Ship Construction.

STERN FRAMES.—No. I.

By Ben Shaw and James Edgar.

The Pattern-making.

Stern frames and stem pieces resemble each other in that they are long and narrow, and in section are practically the same. But stern frames are usually more elaborate in design, and more liable to be damaged than stem pieces. Their similarity in cross-section is, of course, because they define the shape of the vessel fore and aft respectively, the plating being riveted to them. The design of some stern frames is a flat plate instead of the trough section, which, however, is stronger, and is better because the plating is more easily riveted on the frame and short rivets can be used.

The importance of the stern frame being almost a perfect casting is readily appreciated, when it is recollected that apart from defining the shape of the stern, its chief function is to give support to the rudder, and often also the propeller brackets rest on the frame. Thus it has to bear the strain and weight of the propellers and the tail shaft. If a ship is in shallow water and she trims by the stern when she touches bottom, it is the aft end of the stern frame that first feels the impact, and consequently it is no unusual thing for it to be broken even if the vessel gets off again. In previous articles we have spoken of the advantages accruing from making two castings where possible, instead of one large casting, and it will be apparent why stern posts or frames if they are very large are made in two pieces. It is a very awkward and difficult job to replace a broken stern frame, and the cost is enormous, hence although the foundryman cannot remedy a bad design, he ought to see that the best possible castings are made. In this article and the next small types of frames will be considered, but in subsequent articles large stern frames made in two parts will be considered.

It is well that we should examine the design closely before the pattern-making is begun. The frame, of which a front and end elevation, a plan, and two cross-sections are shown in Figs. 1 to 5, is a type sometimes used on small warships. Looking at Figs. 2 and 3 it will be seen that both legs of the casting converge towards the point D, but the trough cross-sections show that the plates on top and bottom are parallel, and thus they do not form flat surfaces, although the design is probably easier for the patternmaker than when the channel becomes wider at the open side. As two methods of constructing the pattern will be dealt with, a block pattern and coreboxes, and a shell pattern, it is presumed when treating of the shell pattern that the shape is irregular and construct it accordingly.

The rabbet, which is shown by the dotted line in

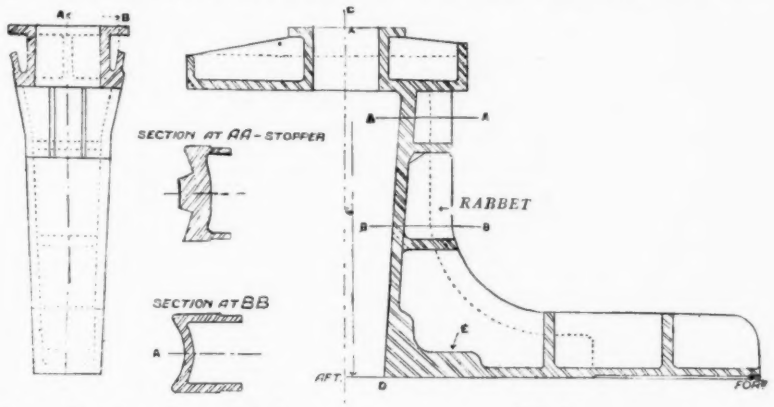


FIG. 2.—SECTION AT *C.C.*, LOOKING FORWARD.

FIGS. 4 AND 5.

FIG. 1.

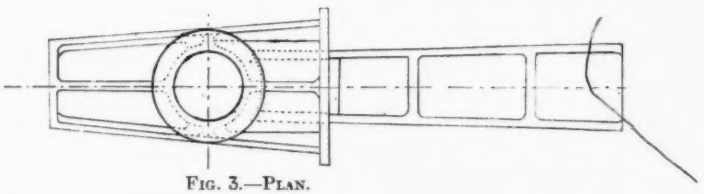


FIG. 3.—PLAN.

Fig. 1, is seen clearly raised in Fig. 2. This rabbet, which is for the plating, is usually about ½ in. deep, and it may be mentioned that no chipping or machining is allowed, care being taken that the moulder does not leave a fillet. The stopper, Fig. 4, is to prevent the rudder swinging too far round. The rudder post, of course, goes through the boss C. A clear understanding of the operation of the stopper and the position of the rudder casting in relation to the stern-frame will be obtained by referring to Part 1 of this series, as the rudder discussed there and this stern-frame were made for the same ship. Incidentally, the increased thickness of metal in the corner E, Fig. 1 besides strengthening the casting, is of considerable value when making a shell pattern in holding it together.

In considering the construction of the pattern several difficulties present themselves and are somewhat baffling. It has to be decided whether the circled face which gives clearance for the rudder post has to be cored off, or made to the correct shape. As we are considering the making of a shell pattern it is as well to construct it to the shape of the casting, and leave the moulder to make a drawback. But because of the difficulty of cutting the shape, the extra trouble to the moulder, and the ease with which a core can be set into the drawback, the best way of dealing with the stopper shape is to screw on a shallow print and make a corebox. It is quite possible to make it without a core, and some moulders would prefer it to being troubled with a core, but on the whole it will be found that the print and corebox is less troublesome. With regard to the circular core through the boss, although in the sketches no print is shown on the inner side, it is a matter for arrangement with the foundry, and in all probability the moulder would want a core, as chaplets are not satisfactory for such a job.

The most difficult part of this casting to deal with is the top. It could be made shell style, but in this form it would give the moulder no end of trouble. As the shape is comparatively regular, it is much better to box it up and core it out. There would be little or no gain in the pattern shop in making it so that the moulder could make a core for the pattern, because all the details, the boss, circular print, and ribs would have to be made in any case. We shall content ourselves in this article with considering the top as being boxed up, consequently the difference between the two forms of construction we shall consider is in the legs. A template would be supplied by the moulding loft to define the front elevation, Fig. 1, and another would be sent down for the trough sections. Although this is not a large job and could be quite well be set down on a drawing-board on trestles, it would not be necessary to do so. Like stem pieces and shaft brackets the lines have to be put on the building floor that the pattern may be accurately built, and while cross-sections ought to be drawn, yet, when the floor drawing is covered the sizes of details can be quite well be lifted from the blue print or tracings, and, if necessary, a scrap view can be made on a small board. This would be advisable when making the corebox for the top core with the circular boss.

A plate has to be planed and placed on the floor on which the print for the top core can be built. This plate should be the total length (A, Fig. 6) and the full width (B, Fig. 6). It need not be more than 1¼ in. thick, and although not shown in the sketch it is better to make it a half-lapped frame. The width depends on core bearance at C, Fig. 1, and should be at least 3 in. or 4 in. Boxes have to be built for the prints, and it will be observed by a glance at Fig. 8 that they are much deeper than the pattern. This is necessitated because of the larger diameter of the branch flange. While a shallower print, say, from the inside of the metal (AB, Fig. 2), might suffice, there is a great and obvious objection to having a part of the flange in the corebox and a part on the print, and it is also simpler to make a parallel box for the print than to follow the shape of the metal. The print should be made deep enough to allow of 2 in. or 3 in. of sand outside the flange.

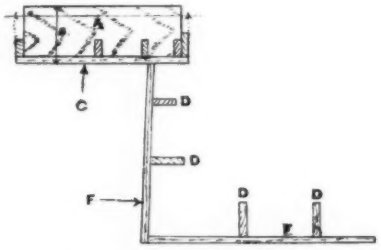


Fig. 6.—Face Plates and Grounds Set Ready for Building.

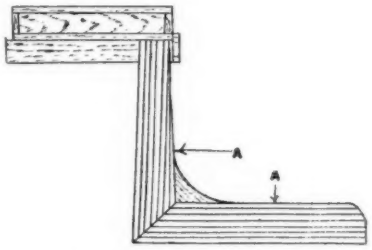


Fig. 7.—Pattern Without Rebate Pieces.

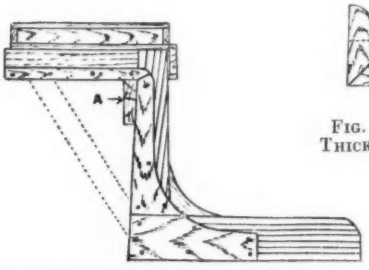


Fig. 10.—General View of Finished Shell Pattern.

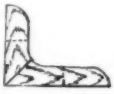
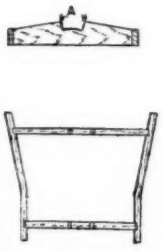


Fig. 9.—Corner Thickness Piece.



Figs. 11 and 12.—Stopper Core-Box.

Fig. 8.—End View of Finished Shell Pattern.

In boxing up the prints the ends ought to be checked into the sides, and the top, instead of covering the sides and ends, should be fitted inside resting on a rebate.

Fig. 6 is a view of the skeleton of the pattern before the covering plates have been built on, the prints not being shown. When the plate C is screwed in position, grounds as shown have to be fitted against it and then the grounds DDDD set in position. As the bottom piece E, Fig. 6, will serve as a ground when constructing the circular face, it should be next laid down. There is really only one way of making the face piece F, Fig. 6, and that is to build in layers using 1½ in. timber. It may be convenient to use a few temporary grounds to get the correct shape of the face. Each thickness as it is laid down has to be bedded against the grounds, after which they should be planed through and the thickness gauged, that the outer face may be planed. When the full depth has been built it will be necessary to lift the piece on to a bench and smooth away irregularities on the surface. The pieces ought to be pocket screwed to the piece C, after which the covering plates can be made, the building being similar to the building of stem pieces, 1 in. to 2 in. timber being used according to the thickness of the metal, each piece being bedded on to the grounds. Glue must not be put on the first piece built, which rest on F and E, as the whole plate will have to be lifted after it is built, to be finished off between the grounds and thicknessed. In Fig. 7 this covering plate is shown with a mitred joint. It is awkward to build it so that the joints of each course will overlap the joints of the previous course laid down, so dependence must be placed upon careful jointing, a screw at the corner, the large fillet made in one piece, and the ½-in. plate which frame the rebate for the plating. If a few ships are being built, and consequently the pattern will have to be used many times, it would be wise to let in a diagonal hardwood piece as suggested by the dotted lines (Fig. 7). It will be noticed that the covering plate is carried right against the top print, which enables it to be well screwed to the piece C, Fig. 6, and also to the grounds which determine the shape of the top trough. For the purpose of finishing off the plate, the mitred joint should not have been glued while building. The plates are much more easily cleaned off in the inside with crank gouges and a short plane if they can be worked right through from end to end, but the outside can be as easily finished when both plates are fastened together. The top covering plate is shown in Fig. 7, as being made of one thickness, but if the face was not flat, or comparatively so, it would have to be built like the other plates. It is one of the difficulties of this class of work, which calls for initiative on the part of the craftsman, that a pattern may be made in a certain way and another pattern will come along very similar, but with some slight modification which necessitates quite a different way of construction being adopted.

The print for the stopper A, Fig. 10, should be carefully fitted because if it is so it will be an additional strength in preventing the pattern from breaking. It will be noted that the ½ in. thickness (Fig. 10) is mitred at the bottom corner like the main plate, the object being, of course, to bind the mitre joint. At the top corner it is mitred because of its narrow width, and also because as the main plate is carried through to the print no benefit would accrue from making a right-angled joint. Sometimes, and especially if the face is twisted, the plate is built to the greater thickness, and the rebate cut with gouges and planes afterwards. This is a long and laborious task, however, if the rebate is wide, and in a job such as we are considering where some dependence is placed on the extra thickness for strengthening the work, it would not be very good practice. If the face was not flat the better method would be to build an extra thickness overlapping the mitred joint, or to bed down a piece of thick timber and thickness it afterwards.

A very important part of the pattern is the extra corner thickness which is shown in Fig. 9. It ought to be built in thicknesses or laminæ and very well jointed. When it has been built the two straight-edges have to be planed, and the shape bandsawn and gouged and chiseled to the required shape.

Great care should be taken that this piece beds well on the plates F and E, as otherwise, when it is screwed in, the pattern will be pulled out of shape. An extra thickness has also to be fitted towards the top of the post (across AA, Fig. 1), but it is an easy matter to draw this piece off and screw it on.

It may be advisable to fit a temporary stay as shown by the dotted lines in Fig. 10, between the

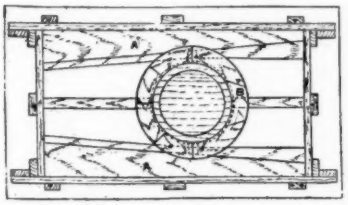


Fig. 13.—Plan of Top Core-Box.

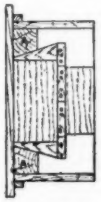


Fig. 14.—Cross-Section of Top Core-Box.

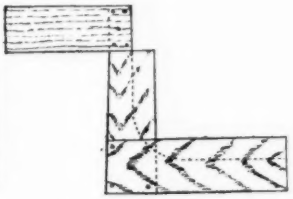


Fig. 16.—Joint Plate of Solid Pattern.

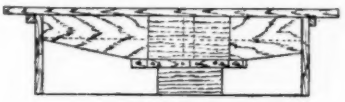


Fig. 15.—Section of Top Core-Box.

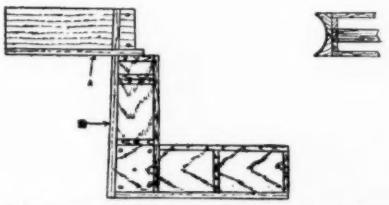


Fig. 17.—Face Plates and Grounds Set Ready for Building.

Fig. 18.—Section Showing Concave Loose Piece.

top and the vertical post, to keep it quite rigid when turning it over to build the other half of the pattern on top, and it may be left on until the pattern is in the sand, presuming that is, that the two halves have not been built on the floor at the same time. Apart from the question of whether it is wise when making such a pattern not to build one half on top of the other, it is not often that there is sufficient floor space, if the pattern is large, to do so.

Building the top half is very similar to building the bottom, except that the half grounds DDDD, Fig. 6, have to be battened to the bottom halves. These grounds are, of course, ribs, and they ought to be so screwed between the plates that they can be loosened off and pulled out of the drawbacks. The top half should be dowelled through the top flat plate, on which the print sits and also on the edges of plates F and E, Fig. 6. Many dowels are often a

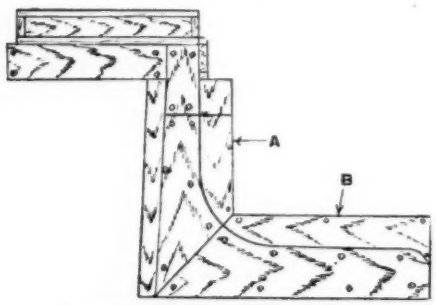


FIG. 19.—FINISHING SOLID PATTERN.

nuisance, but to make sure there is no fin caused through the top half overlapping the bottom half of the pattern there ought to be two dowels in each of the plates F and E and two through the flat plate.

Although the plate A, Fig. 7, on the bottom half is screwed permanently in its position, on the top half the screws ought to be easily accessible to the moulder, as in all probability he will remove them to get away the main drawback. It is well to dowel this plate in position so that it can easily be replaced each time the pattern is going to be used. When a stay fitted as in the bottom half, between the top and the vertical post, the pattern is complete. When the prints

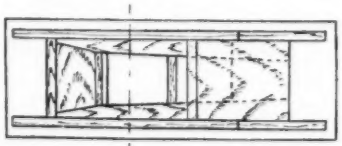


FIG. 21.—PLAN OF TROUGH CORE-BOX.

are being painted the top side should be indicated that there may be no danger of the moulder laying the permanently fixed plate (A, Fig. 7) down in the mould. Fig. 8 is a view of the finished pattern looking in the direction of arrow in Fig. 10.

The coreboxes wanted for this shell pattern are two in number, the stopper box and one for the top trough section with the boss and ribs in. The corebox for the stopper is illustrated by Figs. 11 and 12. It consists of sides and ends. The sides are cut to the shape which is obtained from Fig. 2, and the ends, which will not be square from the bottom edge of the sides because the core and ends of the print are parallel with the face of the large print. If the ends are cut to the exact shape of the core, a straightedge can be used by the moulder for strickling off the top, or if the distance A, Fig. 11, is very short it is better to make the top edge of the ends straight across as shown by the dotted line and plane a piece of timber to slip between the ends and supported by a long batten dowelled on the edges of the ends.

The top core is more difficult to make than the stopper core. In all probability the moulder will want this core in two or more pieces for convenience, but if the patternmaker makes it all in one box he can divide with paper or tin as he wishes. The moulder often prefers to have a complicated core which must be divided into several portions in the one box, because it enables him to see at a glance what is wanted and assists him when making the cores.

It is necessary to make a bottom for this corebox, and as the moulder will want to dismantle the box to get the core out the ends and sides should be fastened to the bottom by means of blocks (Fig. 13).

The sizes of the inside of the box, both length and width, are determined by the print, and the depth is the distance from the face of the print to the inside of the metal, and is obtained from Fig. 1. Blocks (AA, Figs. 13 and 14) have to be shaped for the sides of the core. If the shape is drawn on both top and bottom, these pieces can be sawn to very near the line and finished with planes. They ought to be screwed to the sides of the box, with no screws into

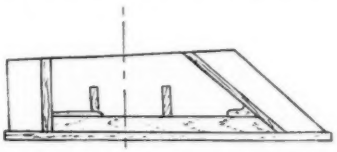


FIG. 20.—SECTION OF TROUGH CORE-BOX.

the bottom. The centre boss should be made solid if it is small, but if it is more than 12 in. in diameter it ought to be built of segments about 1½ in. thick. As it will be necessary for the moulder to draw the flange out of the core into the recess left by the boss, the boss ought to be built to the face of the flange, and the flange fitted on in five or six pieces with a key piece B, Fig. 13, which is the first drawn. The ribs are easily fitted and they also ought to be screwed in place, so that they can be loosened off and drawn from the mould afterwards. The circular print is, of course, kept flush with the top of the box. The three sketches, Figs. 13, 14 and 15, will make the construction of the box quite clear, and we shall now consider the making of a block pattern.

FIG. 22.—SECTION OF TROUGH CORE-BOX.

Two joint plates have to be made for a block pattern similar to Fig. 16. In order that they may be sufficiently strong to support the remainder of the pattern, they should not be less than 1½ in. thick. It will be noticed that these half-lapped plates are made to the faces of the prints, the method of jointing the plates A and B, Fig. 17, stiffening the joint plates very much. It consists of gouging a line on the centre of the plates and sawing out a thickness of plate on each for half the width, so that one plate slips into the other at the required angle. It will be necessary to cut one of the plates of the top print to allow the plate B to pass through, but that is a simple matter. The top print, and, indeed, the whole of the top part of the pattern has to be constructed in the same way as for the shell pattern, so we can confine our attention to boxing up the vertical post and the bottom horizontal piece. There is a choice of two

methods: either the shape of the pattern may be boxed up or the boxing may be to the face of the print and the inside of the metal, plates being screwed on the boxes afterwards to form the shape of the metal. This is no gain from making the prints separately, and a great deal of extra labour. It is much more practical to box up to face of the prints. Grounds which are shown in Fig. 17 have to be made on which the front and top plates can be screwed. They ought to be about 2 in. thick. The top plates

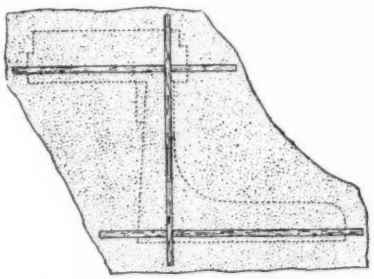


FIG. 23.—LEVEL BED FLUSH WITH FOUNDRY FLOOR WHEN BOXES ARE USED.

are shown in the sketch mitred. This is not essential, although it is probably better if the surfaces of the plates have to be touched up after being screwed on, and, of course, mitreing prevents end and side grains from being on the same face, which the patternmaker should always guard against, as the pattern always delivers better from the sand when faces are either all side or all end grain. In the upright post two grounds will have to be screwed together because of the break in the shape. If the front plate at A, Fig. 19, is carried right through to the bottom plate of metal, and the front plate at B fitted against it, the joint plate will be well strengthened, but probably the strongest job is obtained by checking the one into the other in similar fashion to the pieces A and B, Fig. 17.

We have yet to deal with the concave face on the inside of the upright post. The joint plates and the piece B, Fig. 17, ought to have been kept back 1 in. or so from the point A, Fig. 5, and now blocks planed out and gouged to the section at AA, Fig. 1, should be screwed on the face, the object being that the moulder can unscrew those pieces and draw them into the mould. The alternative method would be to core off the face, which would be clumsy and give the moulders needless work, and the other way is to box up to the finished shape and force the moulder to make a drawback for the concave face. By making the loose pieces he can either use a drawback and

FIG. 24.—SIMILAR BED SUNK IN FLOOR WHEN PATTERN IS BEDDED IN.

draw them in, although it is almost certain that no drawback would be made, as no advantage would be

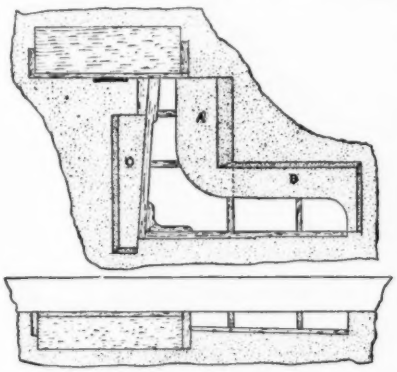


FIG. 25.—HALF PATTERN BEDDED IN.

gained from making one. Fig. 19 is a front elevation of a finished solid pattern, the top thin plate which forms the rebate being left off, and as in the shell

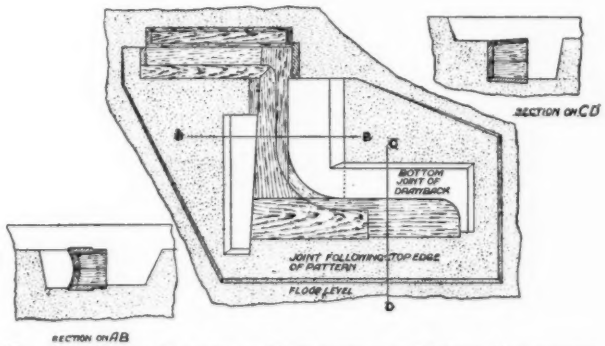


FIG. 26.—MOULD RAMMED UP PREPARATORY TO MAKING DRAWBACKS.

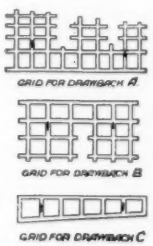


FIG. 27.

pattern no circular print is shown on the inside, although one would probably be used.

The additional core for the block pattern may be made in one or two boxes, but it is suggested that two smaller cores are better than one large core because of the awkwardness of handling the large core, and we shall only consider the small core here. It is as well, though not essential, to mitre the cores. Figs. 20 and 21 and 22 are three views of a corebox for the vertical post core. Fig. 20 is a longitudinal section, and Fig. 22 a cross-section. A bottom is necessary, and the sides have to be planed to the correct taper. On the bottom a convex piece is screwed and the ribs and extra thickness pieces also fitted, but before the ribs or thickness pieces are

fixed in, pieces have to be screwed to the sides, as while the box sides are parallel the core is, of course, tapered in the length. It will be necessary for the moulder or coremaker to dismantle the box, but the pieces that are screwed on the bottom will not be removed. The ribs should be screwed from the sides of the box so that the moulder can conveniently get at them. The corebox for the adjoining core is made in so similar a way that it is not necessary to explain it. Of course, there is no convex piece on the bottom, the sides of the box would be parallel, and it would not be necessary to fit taper pieces inside against the sides as the box itself could be tapered by making the ends of different widths.

stiffeners used, all assist in making the preparation of the mould, to ensure a sound casting, one which necessitates the most careful treatment. When the equipment of the foundry will allow, it is better to use boxes, not only for greater convenience in drying, but also to give greater freedom to the foundryman in determining the best position for casting the metal. It is only on rare occasions that the moulds can be arranged for pouring vertically, but an advantage can often be obtained by canting the mould so that some parts get a better head of metal, producing a greater pressure and ensuring denser metal where more strain

FIG. 29.—SUITABLE GRID FOR HALF-CORE.

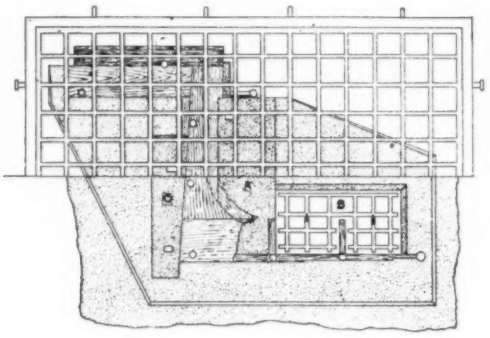


FIG. 28.—PREPARING THE DRAWBACKS AND COVERING.

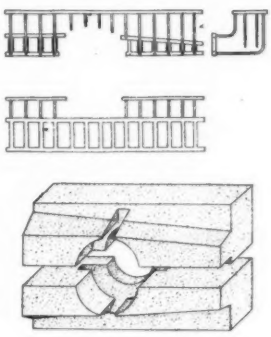


FIG. 30.—PERSPECTIVE OF THE TWO HALF-CORES.

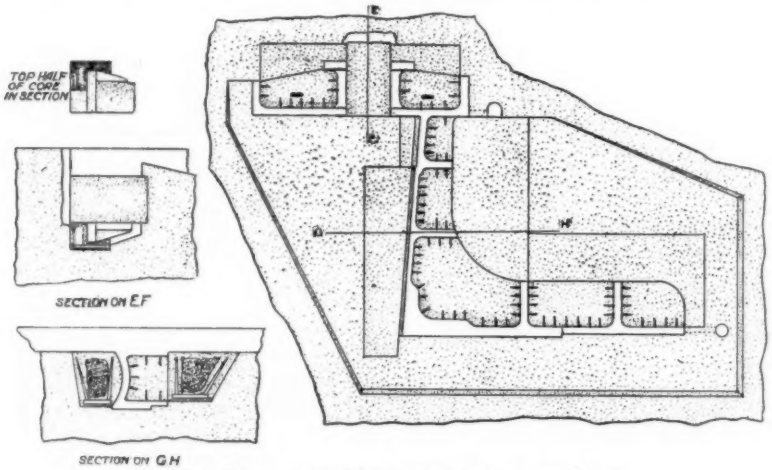


FIG. 31.—FITTING THE MOULD PREPARATORY TO CLOSING.

The Moulding.

We have already said that among the difficult castings used in ship construction are those embodied in the formation of the stern, and not the least of these is the stern frame. The special function of this class of casting makes it imperative that a sound casting be produced; especially is this condition essential when, besides being a support for the rudder, it provides the aperture for the tail-end shaft and supports the weight of the propeller, as in the case of a vessel with a single screw. The unwieldy nature of this type of casting, and the varying thicknesses of metal encountered in the designs, together with the cross is likely to accrue on the casting. Not infrequently, however, although the foundry may be well equipped, the size and general awkwardness of the design—from the moulder's point of view—leaves the foundryman no alternative than to make use of the foundry floor to form the drag. When this is forced upon the most highly equipped steel foundries, it follows that those with inferior or less equipment find it necessary to make use of the foundry floor for practically every casting of this character. Although there is not the same freedom for running the job when the floor is used still the mould can be canted; but in whatever position it is desirable that the mould should be cast,

that position must be decided at the commencement as the mould cannot afterwards be moved. While this method can be adopted, it is much more inconvenient to work, and the cant must be comparatively small, hence little advantage is obtained, and taking into consideration the extra work involved in the process, the practice cannot be recommended for this type of casting. The methods actually employed are, therefore, governed by the capacity of any foundry for such work, and diverse opinions are held by foundrymen according to what their practice has been, and the degree of success which has attended their efforts.

The example under consideration is, as was said when dealing with the pattern making, one of the more general types used in the construction of light warships, and the methods described and illustrated cover the more common practice for this particular form.

When the pattern is made similar to the required casting, except, of course, for contraction, the mould can be made in a two-part box, but it is not very convenient to do so. The shape about the rudder post support and the rudder stopper can be made more conveniently by cores, and would appreciably reduce the work in the foundry, but the remainder is preferably left so that suitable drawbacks can be made. The pattern being in halves is of a fragile nature and requires careful handling to preserve accuracy. A level bed is prepared and half of the pattern laid on it, as shown in Fig. 1. Before the drag-box is set over this, it is better to make up the prints for the drawbacks, although many prefer to cut them out after the box is rammed up and rolled over. The insides of the frame should be packed up with bricks as much as possible, to give a good support to the web when ramming the bottom, and the shape of the drawbacks, following the inside of the web formed up with the floor sand. The same process is required with that part of the frame which is concentric with the rudder, since the pattern cannot be withdrawn satisfactorily without a separate lift to overcome the difficulty of the curve. The screws securing the stiffening ribs are removed and parting sand applied, preparatory to lowering the box part. Before a commencement is made to ram up, it saves trouble to fix a few screw eyes into the pattern at convenient places and just projecting above the box, then, after the box has been rammed up the pattern can easily be made secure before rolling over. This method of preparing the drag is by far the best. The work is easier, the sand is more readily consolidated, and a truer shape is more likely to be attained with less rough usage to the pattern. When it is not convenient to adopt this method, then the bedding-in process is used, but, instead of making the joint of the pattern flush with the foundry floor, the work in the top box can be reduced by sinking the job until the uppermost part of the pattern is level with the floor. This removes the necessity of having special box bars. A similar bed is prepared, but at a depth below the floor level equal to half the highest part of the pattern, as shown in Fig. 2. A rough shape of the pattern is marked on the bed, and the sand is cut out deep enough to allow it to be lowered in. Stout battens should be screwed to the joint of the pattern to maintain its rigidity as much as possible, and to hold it flush with the bearers when the pattern is set in position. The sand at the sides, forming the bed, can be removed to allow the moulder access to the bottom of the pattern in order to tuck the composite against it. This requires to be done very carefully to retain the true shape. When a number of bearances have been made the pattern can be lifted, the bottom screws removed from the stiffening ribs and returned to its position for a final ramming of the compo under it. The battens can be removed and the surface tried with a parallel straightedge and a spirit level. About the inside of the frame, a bearance can be made up for the drawbacks marked A and B in Fig. 3, and following off the inside surface of the web. On the outside and below the print for the stopper core a bearance is formed off the pattern for the drawback C. Much of the sand about these can be rammed up before the top half of the pattern is placed. Boards can be set up to give a good taper to the required drawbacks, and the sand rammed against them. It will be noticed that a considerable taper is given to the sides for the drawback A, which in this instance is made to follow the dotted line as shown in Fig. 3. This allows clearance in stripping from the convex part of the pattern when the ramming has proceeded high enough the other half pattern may be placed and a weight used to hold it in position, and the ramming continued to follow the top surface contour of the pattern, forming a joint and then tapering up to the floor level as shown in Fig. 4. While this outside ramming is in progress it is necessary to remove the screws holding the ribs. The general formation of the joints in relation to the pattern are shown in the sections on AB and CD, Fig. 4. When the various joints have been made satisfactorily, the drawback C forming the

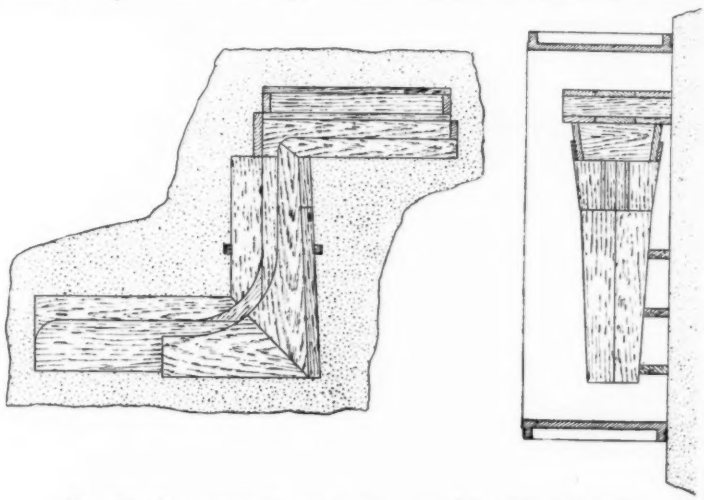


FIG. 32.—SUPPORTING BLOCK PATTERN FOR ROLL-OVER PROCESS.

concave side of the frame should be rammed up. It is necessary to make this drawback first, so that the pattern will be supported when the top web is removed to make the other drawback A and B. No special care is necessary in the construction of this drawback as there are no contraction difficulties with which to contend. An ordinary form of grid, shown in Fig. 5, will suffice for lifting it, having a number of prods cast on so that the sand will adhere firmly; this is bedded into a bearance of composite and rammed up the contour of the pattern, using about 1½ in. of compo against the pattern, and backing up with the floor sand. The top web of the pattern can then be removed and preparation made for the other two drawbacks. The stiffening ribs will then be quite loose so that a little care is necessary to keep them in position while these drawbacks are being formed. Prepare the bearance of drawback A with "compo," and bed in the grid shown in Fig. 5. In this case contraction must be taken into consideration, and as

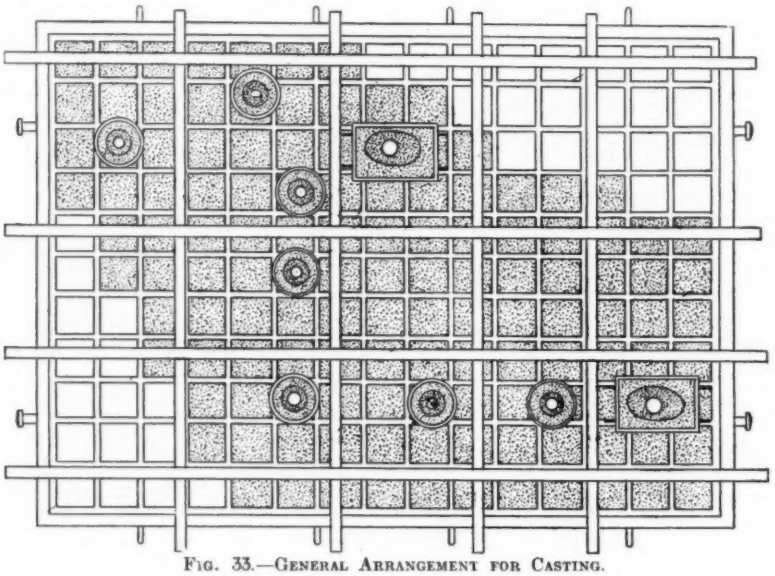


FIG. 33.—GENERAL ARRANGEMENT FOR CASTING.

the grid strengthens the sand so much the moulder should be cautious to form the grid so that it will be well clear of the pattern lengthways, and in such a way that the sand separating the ends from the mould will be crushed under the strain. This drawback should be built up with "compo" to form a hollow box, ashes being rammed inside to weaken it and reduce the strain on the casting shortly after pouring the metal. A covering of "composite" is given to the surface, the top web bedded in, and the joint of the drawback made to correspond with the top contour of the web. Remove the web and make up the joint for drawback B, and proceed in a like manner, using a grid similar to that shown in Fig. 5. Instead of using dabbers or prods with these grids, pieces of wrought iron are frequently used where the strain on the core is likely to be more severe, and, as they give more freely during the time of contraction, the method is to be recommended. The relation of the grid to the drawback is illustrated in the bottom half of Fig. 6. During the process of ramming up the drag it is necessary to decide on the method of running the job.

For work of this character many moulders prefer a single gate, with a runner to the end of the mould almost equal to the full depth of the frame at that part. This is an advantage when all the metal required can be carried in one ladle, when, however, a ladle of the right capacity is not available a supplementary gate is necessary. Such a gate is shown in Fig. 6. The runner can be made to follow up against the drawback, thus it need not be made flush with the top of the mould.

When the drawbacks have been formed with the web of the frame in its correct position, and pieces of iron plating covering the lifting staples, the cover box can be set and the cope rammed up. To carry the top lift, which is considerable in some parts, gaggers are frequently used, but so many would be required that it is preferable, especially when the joint is comparatively flat, to cover the mould with "composite," and bed in pieces of grid before the box is lowered over, then these grids can be secured to it. Set in risers where the section of metal is heavier, so that a certain amount of metal can be drawn from them. Their position is indicated on Fig. 6. It is necessary to set a riser over the flange of the rudder post aperture, and careful measurement is required to fix the position. The whole of the cope box need not be rammed, only as much as will ensure a safe lift being necessary.

While this is in progress the cores for the top part of the frame, the stopper, and the rudder post can be prepared. Though the box for the former is made as one, it is preferable to make the core in two separate pieces for convenience in setting the rudder post core. Hence two grids are necessary, and, as each part of the core is of a peculiar shape, a special form of grid is required. Such a grid is shown in Fig. 7, having wrought iron pieces bent to shape, with a casting grid at the ends. Though a little more trouble is caused in forming the grid it gives very satisfactory results, being light yet comparatively strong. The bottom part of the core, carrying the longitudinal rib, can be formed up first following the same practice as with the drawbacks with regard to ashes where possible. The other part of the core can be proceeded with at once if paper is used to cover the joint between them. The general appearance of this core made in halves is shown in Fig. 8.

When the top box is rammed up, its position determined, and the gate and riser sticks withdrawn, it is lifted and supported on stands, so that the cope is accessible to clean up; the withdrawal of the pattern can then be commenced. The loose web on the top

requires to be removed temporarily, and the drawback B lifted, carrying one of the stiffening ribs. The removal of this drawback releases the drawback A, which should follow the bevel at the back, in order to clear the convexity of the pattern. When these two drawbacks have been withdrawn it is better to replace the top web, and secure it well to the rest of the pattern to stiffen it for lifting the top half away. After this part of the pattern is taken out, the drawback C is free and must be withdrawn to allow the remaining section of the pattern to be stripped. The print for the rudder post core can be drawn into the mould, and a commencement made to prepare the mould for stoving. It is necessary to use a considerable number of nails to strengthen the sand, especially projecting corners which are to be left sharp. The sand about the top end should be eased out while the sand is green, to allow the rudder post-core being lowered into its relative position, and the moulder must rely on measurement. The two half cores forming the rudder post support, and also the two inside drawbacks, require special treatment while they are green. Sharp corners, representing the junction between the webs and the body of the casting need to be rounded off, and, besides being well nailed, they should be cut to form small brackets on the casting as shown in Fig 9. These brackets are most useful in preventing the possible rupture of the casting due to shrinkage. Being thin—about ¼ in.—they solidify quickly, and in this condition they give a support in angular sections when the casting as a whole is at the point of solidification. The semi-fluid metal being weak, is very likely to rupture owing to the comparative quickness in shrinking.

The core for the rudder post can be made either about a vertical spindle or on a horizontal spindle, and since the core is laid horizontally in the mould, the latter method is preferable. Pieces of iron bedded into the composite during the time of preparing this core, and in a line with the spindle, will suffice to stiffen it if they are wired round before the final coat of composite is applied.

The cores and drawbacks can be more conveniently dried in an oven, but the mould will of necessity require to be dried in place with the cope box supported or suspended over it. When moulds, drawbacks and cores are dry, and any cracks which may have formed carefully filled up, all those parts with which the molten metal is to come in contact require to be painted in order to obtain a good face on the casting. A good application of silica paint will give the required result, the whole being afterwards thoroughly dried. Runner and riser basins should be prepared, so that they will also be painted and thoroughly dry when a commencement is made to close the job for casting.

When all parts are dry, and the sand about the junction of the runners and risers with the mould is well rounded off, the whole mould can be put together.

The drawback C is most conveniently set in position first, as this allows the stopper core being set more accurately. The drawback A is then lowered into its relative position. To be quite sure of its position being maintained during the time of casting, chaplets are nailed to the web part of the mould in the bottom and the top of the drawback. These drawbacks take very little time to set, and the staples can be covered and hot bricks or iron used to dry the "compo." The core forming the shape about the rudder post support is more difficult, and requires the exercise of care. Both halves are of a fragile nature the bottom half, jointed off the surface of the horizontal rib, is lowered into the recess, then the rudder post core can be set in position. A belt slinger is very useful for cores of this kind. This core requires to be moved along to get a support at each end, then the remaining half core is lowered into its correct position, maintaining the rib thickness by means of a chaplet. Sand can then be rammed behind the rudder post core to keep it firm against the shallow print. The general appearance of the mould is shown in Fig. 9, the sections on E, F, and GH illustrate the relation between the cores, drawbacks and the mould. With the mould fitted together, and the parts secured where necessary, the cope box can be lowered and preparation made for casting.

When a block pattern is supplied, and many foundries prefer such a pattern for this class of work because of the greater rigidity, either a box part can be used for rolling over, as shown in Fig. 10, or the bedding-in process can be adopted. In the former instance, instead of half of the pattern being set on a prepared bed, it is better to secure the two halves together and set the whole pattern on the bed, so that when the box is rammed up and rolled over the highest part is just flush with the joint. The pattern being comparatively strong, can be supported as indicated in Fig. 10, so that its centre is parallel to the bearance. After the pattern is set in position, the joint can be made up with bricks and sand to follow the shape of the pattern. It is easier to make up the joint in this way than cutting it out after the bottom has been rammed. When a block pattern is made for a frame of this design the concave portion and the stopper can be attached in a readily removable fashion so that they can be drawn into the mould after the main part of the pattern has been withdrawn. The method of procedure would be similar to that already described, excepting that the cores would take the place of the drawbacks, the assembling of the mould would be similar in every respect. This style of pattern reduces the work in the foundry, and it is to be advocated if many castings are required from the same pattern.

It is usual to cast these on the level, and Fig. 11 illustrates the general arrangement. When box parts are used there is the advantage of using bolts to secure the two parts, or bolts are passed through slot holes in the heavy metal bars to be fastened to the drag box.

When the job has been cast the gates and risers should be cased as quickly as possible, and when it is safe to remove the cope box, the inside drawbacks or cores also require easing. The same precautions with regard to annealing as have been noted in previous articles are equally essential for stem frames.

WOODWORKING MACHINERY.—At the recent Lyons Fair, one of the more notable exhibits was that of Messrs. Thomas Robinson & Son, of Rochdale, who last March attracted a large amount of attention with their display of wood-working and other machinery. This stand contains a roller-feed sawbench for high-speed swage sawing, with patented device for altering the length of the radial arm, and a 40-in. sand papering machine for finishing all classes of woodwork. Two different types of moulding machines are on view, one a four-cutter with all cutter spindles running in extra heavy self-aligning ball-bearings, and the other a small type of massive construction, with all parts accessible and easily adjusted. In this machine the feed-gear consists of four driven feed-rolls, the gear being enclosed in cast-iron covers. A weight applies pressure to the feed-rolls, and a lever working against a notched quadrant controls the feed, enabling the latter to be instantly started or stopped. A mortising machine is shown, especially designed for cutting mortises of various lengths by a chain cutter. Very small mortises can be cut—in fact, square holes—by the hollow chisel operating in the same line as the chain cutter. A small circular saw bench has the pillar made of a strong cored casting, and a broad base. The saw spindle is ground true, and runs in either adjustable ring-oiling gun-metal bearings or ball bearings, the spindle being so arranged that the saw can be replaced with a cutter block for tonguing and grooving, or working moulds up to 1¾ in. wide. Other machines at this stand comprise a light circular moulding machine with non-reversible cutter spindle, a moulding and planing machine, a horizontal log band mill, a hand-feed planing and surface machine, a two-spindle saw bench, and a band-sawing machine.

XUM

Annealing of Castings for Machining.

At a meeting of the members of the Lancashire Branch of the Institution of British Foundrymen on November 1, Mr. S. Roe presiding, Mr. W. H. Cook, M.I.Mech.E., of Heaton Chapel, gave an address on the "Annealing of Castings as an Aid to Quicker and Cheaper Production in the Machining Processes."

He said the process of annealing castings had been in use for many years, but it had not been adopted to any extent in the generality of foundries. The greatest users were found in the textile machinery branch of the engineering industry; in that branch its advantages had been most fully recognised. No doubt there were many reasons why it was not employed more fully, the principal ones being:—(1) Lack of knowledge of the process, (2) mistaken ideas of the cost, (3) doubts as to the influence of annealing on the wearing qualities of the castings..

After many years experience, during which they annealed 20 tons per week, and, during recent years, from the observation of plants that they had installed, he had no hesitation in saying that the cost of annealing was repaid many times over by the saving in the cost of machining, due to the greater speed at which the work could be produced, and the longer life of the tools. An additional advantage was the vastly better finish that could be put upon the work during machining. He did not find that there was any bad effect upon the wearing qualities; in fact, in many cases, it was beneficial.

Considerable discussion had taken place as to the effect upon the chemical constitution of the metal, and the general conclusion was that there was practically no change; but the molecules of the casting took up dfferent arrangements, and became more regular in their relative positions to one another; it seemed to make the granular structure much closer. This was very evident when the casting was examined under the microscope, or if two roller castings, one annealed and the other not, were broken and compared. It was well known that from several causes, such as variations in the temperature of the metal during pouring or in the moisture in the sand, castings acquired a structure and hardness which was very destructive to the tools used in machining. The process of annealing removed any strains due to the foregoing, and also any hardness which might have arisen.

Certain mixtures of metals lent themselves to the process better than others, but there was no real reason why satisfactory results should not be obtained from almost any mixture. At one time they thought it absolutely necessary to use a certain expensive brand of pig-iron, but during a scarcity of this brand they used a much cheaper one with results so satisfactory that they had not returned to the expensive brand. It must be borne in mind that excessive amounts of either Scotch or hematite iron would give open castings, which might not be suitable for certain jobs.

There were several rough-and-ready methods of annealing, where small quantities were treated, such as throwing the casting into the bottom of the cupola after casting was finished or taking the casting whilst hot and burying it in hot, dry sand: but such methods gave irregular results. It was only possible to get good results, and to treat large quantities of castings by the use of properly constructed furnaces or ovens. Of these there were several designs in use, and the one which he himself had found to give the best results was shown in two drawings which he exhibited.

This furnace was designed to deal with charges of 30 cwt. Two furnaces were built side by side, so that whilst one was cooling off and being recharged the other was in operation, thus giving a constant output of 30 cwt. per day. Where greater quantities were required furnaces could be duplicated. The space occupied by each furnace was above the floor level, 19 ft. by 8 ft. 6 in., and below the floor level (includng flues and firing pit), 27 ft. 6 in. by 13 ft. 7 in., the depth below floor level being 4 ft. 3 in.

It would be seen that the firing pit and firing box were on the right hand. The heat passed over a bridge 18 in. wide, with an opening 6 in. wide, and then circulated amongst the boxes and gradually brought them up to a heat of 700 deg. C., or to the point of turning white. It then passed through the fire ports into the under flues, and thence into the main flue. The main flue must be of sufficient dimensions; otherwise the whole oven would be a failure. In this case the dimensions were 21 in. wide, and 27 in. deep, coupled up to the main boiler chimney. He strongly emphasised the point that the flue must be sufficiently large. If it were too small they got back pressure and insufficient heat. He had had to do with a lot of furnaoes, and had never known one that equalled the one he was describing, and he attributed it to the flue.

On looking at the front elevation it would be seen that the whole structure was held together against the expansive action of the heat, by cast-iron corner plates and tie bolts. The whole of the surfaces which came in contact with the heat were lined with fire-brick.

The castings were thrown into boxes, 16 in. by 14 in., until full; cast-iron borings were shovelled in at intervals, and the box was knocked with a heavy hand hammer to cause the castings and borings to form a solid mass. Two lugs were cast almost at the top of the box, for the purpose of enabling it to be carried by a bogie into the oven; and a litle below the centre were two round lugs for the purpose of handling by chain blocks or a small crane, which lifted the box and inverted it to empty out the castings, Practically any kind of cast-iron borings could be used. Two boxes were put on the top of each other. In some cases a lid was put on the box, and plastered up with fire clay. If the castings were well covered with borings that did not seem to be necessary, but he would give this warning: never have the castings too near the top. If the casting by any means came in contact with the atmosphere there would be a hard side and a soft side to it.

When the oven was full of boxes the doors were closed and plastered up with fireclay, and the fire lighted. The firing continued for nine or ten hours, during which time about 30 cwt. of gas coke was used. The heat was kept in as much as possible. They found if they got anywhere round about 750 deg. they had as much heat as was necessary. Some people used a pyrometer. Personally he had not found that apparatus very successful; there was always something going

wrong with it. If one could get a good pyrometer it was the best method to follow, to depend upon the pyrometer and get the heat up to 750 deg., but a skilled annealer never needed a pyrometer. People could heat a lot of pig-iron and say what it was good for, without requiring an analysis of it or discussing whether there was so much phosphorus, so much sulphur, and so on; they knew from experience whether it was right for certain jobs. It was the same with the annealer. He looked through the peep-holes, he watched until the material came to a point which could scarcely be defined, but what was known from experience, when it began to just turn over to white. It seemed they had to go up to that point to give the molecules time to change into the desired position.

After the firing had been completed the ovens were allowed to soak until the following morning: the boxes could then be drawn and allowed to cool off, the ovens being recharged and made ready for firing again. Two men would attend to the two ovens, and anneal up to 10 tons per week.

In estimating the cost, he took it that for a weight annealed of 10 tons there would be used 8 tons of coke at 35s. per ton, making £14, and the labour of two men for a week at 60s. each was £6. Adding wear and tear and overhead charges £6, he arrived at a total of £26; say, 50s. per ton, or 2s. 6d. per cwt. Comparing the saving in cost in the machining processes, it would be readily seen that the cost of annealing was saved many times over.

Mr. Cook proceeded to exhibit a number of samples of annealed work. Two of these were castings for top rollers. He said it was interesting to compare them with two similar articles, unannealed, and observe the change which had taken place in the colour and the structure. The annealed castings were closer and duller. Another sample was a finished roller. In machining an unannealed casting the surface speed for sliding could not be more than 32 to 36 ft. per minute, and even at this speed the tool would not slide more than 20 to 30 before regrinding; whereas with the annealed casting the speed was 80 ft. or more, and the tool would slide several hundred before regrinding. The total pre-war cost for finishing this article was not more than 1½d. each. The sleeve bobster and inner tube of a ring spindle would cost at pre-war wages about ¾d. each; without annealing it could not be finished for less than 3d.

A spindle of hardened steel, with the bearing of annealed cast-iron, had run at 9,000 revs. per minute for 30 years without showing any great wear.

Another sample was a hand grenade. When they began to make these, a tap which would tap 100 was considered a good one. After they put down the ovens the taps lasted for days, and would sometimes tap thousands.

He hoped his remarks had been of interest to the members, and would be of service in the future. If further information was desired he would be glad to give it. It was his intention originally to couple the process of pickling with annealing, but it occurred to him that too much time would be taken up by the paper, and questions and discussions would be checked. He therefore deferred the consideration of pickling.

Discussion.

Mr. Haigh said he could not quite see the reason for filling the boxes with cast-iron borings. If machining was not to be done he took it there was no need to go through the secondary operation of annealing unless the object was to benefit the material in strength and toughness. He gathered that Mr. Cook's aim was to make the subsequent machining easier and quicker. He supposed the samples were cast in chills.

Mr. Cook: I never use chills. They have all been sand cast.

The Chairman: You stated some time ago that your mixture was a ton of borings and two cwt. of iron ore. Is that the best annealing material?

Mr. Cook replied in the affirmative. Borings were very low in price. One could do with anything really if the boxes were kept air-tight.

The Chairman asked if any chemist could tell them whether the borings had any effect in the way of changing the casting chemically. The borings were cast-iron in a very finely divided state.

A Member asked whether gas coke was the best fuel to use for this purpose? Could producer gas be used?

Mr. Mills said he did not think annealing had the slightest effect chemically upon the casting. Anything that excluded air did as well.

The Chairman: Do you think the slight amount of ore mixed with the borings would have any beneficial effect?

Mr. Mills: I do not think it would have any effect. I would like to ask Mr. Cook if he can give us any data as to the effect of annealing on the strength of the casting. Personally I have found that it has a slight reducing effect—about 10 per cent. on the average; but others say there is an enormous decrease.

Mr. Simkiss said he had annealed many thousands of tons, and had sufficient proof of the soundness of annealed castings. On some little points he did not quite agree with Mr. Cook. His experience was that it was always advisable to use good quality metal, and he knew that an endless spindle made of such a metal had run for 20 or 30 years without any appreciable wear. He made exhaustive experiments, using any irons, but could not get equally good results; therefore, he advised all who took on annealing work to use good quality metal. A point which Mr. Cook omitted to mention was the growth of annealed castings. In small articles, such as had been shown, it was not very appreciable; but in annealing bars, say 2 ft. long, there was a growth of perhaps a quarter of an inch. This must be taken into consideration. Then the members might have been instructed more fully as to the chemical alteration. An instance in point was the following analysis:—

	Before Annealing.	After Annealing.
Iron	92.83	92.90
Combined carbon	2.96	0.08
Graphitic carbon, a trace		2.91
Silicon	2.01	1.89
Manganese	0.605	0.578
Sulphur	0.097	0.117
Phosphorus	1.496	1.220

It would be observed that the combined carbon was practically converted to graphitic carbon. Most people who took up annealing did not believe in high silicon, but he did; he thought it ought not to be under 2.5 because the silicon was very essential for the transference of the combined carbon to what might be termed annealing carbon. Sulphur was a most troublesome element; the freer the materials were from sulphur the better the

result. They would get a skin on the casting. He thought the comparison made it clear that a small chemical change took place.

Another point that was not mentioned in connection with the making of small castings for annealing purposes was the effect of moisture in the sand. It was very essential that damp sand should not be used in making the moulds, because it had a deteriorating effect upon the skin of the casting which annealing sometimes failed to take out. Then with regard to strains he had proved that strains were greatly alleviated by annealing.

He used pots with an inside diameter of 11 in. and 18 in. deep. They were run out on a bogie, as Mr. Cook had described, and emptied by hand; they were just thrown over a block of wood so that the materials rolled out. He advocated covered pots with lids. With the open design there was a great tendency for the top row of pots to get at heat long before the lower pots came to the same temperature. The lids to some extent took up heat and prevented the top portion becoming too quickly at heat. After many tests of both cast-iron pots and steel pots he found the former preferable. The best were made with a big percentage of burnt material, so that the pots were white to begin with, and there was very little distortion. Another important point was the damper arrangement. The six holes in the ovens were so arranged with dampers that one could shut off any time, thus drawing the fire to any section of the oven that was not given the same heat as the remainder. The amount of coke used was said to be 30 cwt. That might be somewhat misleading to those who were thinking of going in for annealing. He himself had been annealing with about 20 cwt. per oven.

The pyrometer was an awkward thing to use, because it could only be inserted through one of the peep-holes, either back or front; there was no means of taking it to the centre of the oven, or to the lower pots, so as to get the heat. The correct time that the oven was at heat was got by practice and by sight. Those who were expert in annealing could pick it up almost immediately, they could see when the pots were thoroughly soaked through. It was only by practice that could be done. Some years ago small bricks were introduced, which were designed to melt at certain temperatures—500 deg. and so on up to 1,000 deg.—and these could be placed about the oven. That was a very good idea for ascertaining the heat at various parts of the oven as long as the bricks were kept within sight of the peep-holes at either side, front or back. The 750 deg. mentioned by Mr. Cook was on the low side. The heat must be sufficient to get to the annealing point, where the carbon change took place. In his opinion that was about 850 deg. Fah.

Mr. Cook: I was speaking about Centigrade.

Mr. Simkiss added that he did not know why the hand grenade shown had not been machined without annealing. He should imagine there was some cupola trouble there. With regard to the materials used for annealing he used coal dust mixed with a very small portion of iron ore. Some tests he had taken showed that the tensile strength of the ordinary inch bar was reduced about 25 per cent. For fuel, as at present advised, he preferred ordinary gas coke, but he had annealed many hundreds of tons with gas from a producer, and in the early days, going back some 30 years, coal was used.

Mr. Cook said he had already stated that anything that would keep the atmosphere from the castings would do for filling up the pots. He had seen coal dust mixed with ore tried, but he should still use cast-iron borings because they were there available, and they did not seem to have the slightest injurious effect. However, Mr. Simkiss had a longer experience, and he should know. With regard to the tensile strength, he had never known it to be reduced 25 per cent. and he had taken many tests. He admitted right away a test bar unannealed would be stronger than a test bar annealed, but if the skin were first taken away there would be very little difference. Some of the tales he saw in the papers about the effect of annealing, and about what people had been able to accomplish and what they had not accomplished, he attributed to their not knowing what they were dealing with; they had done no annealing previously. With regard to fuel, anything that would get up the heat would do, but nothing that he had ever touched equalled coke for economy and simplicity. The type of man employed on this ju did not like to bother with a lot of intricate apparatus. Coke was easily handled, and the men knew how to deal with it, and if they used a little too much it did not matter; whereas if gas was not mixed in the proper proportions the heat might reach a thousand degrees at one time, and then drop down to a very low figure. That was especially a drawback with producer gas. His experience was that producer gas was not economical because it varied so much in its value. He should still stick to coke. He was not going to dispute Mr. Simkiss' statement that there was a chemical change, but one test was not much to go by. One could apply half a dozen tests to a casting and get half a dozen different results. Even if there was a change it did not matter in regard to handling and working the casting, and he was speaking from the point of view of the practical man.

Mr. Simkiss stated that they sold all their old pots and bought new ones. There were firms in the Midlands who both purchased old pots and supplied new ones at a cheap rate. They came in white.

Mr. Cook said he had never had that experience.

Mr. H. Sherburn said it was generally accepted that in annealing the main change was the conversion of combined carbon into the tempered form or graphitic form. The analysis quoted by Mr. Simkiss might mislead people who were not very careful. What was the atmosphere of an annealing oven? Obviously an oxidising one. Therefore, they might expect oxidation of some of the other elements to take place, but he did not think anyone would suggest that the annealing operation would bring down the phosphorus from 1.496 to 1.220. That was obviously impossible; otherwise it disclosed a new method of removing phosphorus from iron mixtures which had been a difficulty for generations. They should realise that the whole practical question was one of changing combined carbon into a more machinable form; viz., tempered carbon or graphitic carbon. Had Mr. Cook any experience of muffle furnaces for annealing? He meant, of course, the extremely heated type in which the products of combustion did not come in contact with the charge. There, of course, one got a much lower tendency for any oxidation of the charges themselves to take place, such as was suggested by the analysis supplied by Mr. Simkiss. Dr. Carpenter had explained why growth took place. The silicon was converted into an oxide which occupied more space, and hence the casting was larger after the annealing process. He had seen a continuous system of annealing which was

obviously the best method. It was not a question of placing pots in an oven, heating them up, cooling them down, and so forth. There was at least one process in operation whereby the furnace was kept at the requisite temperature the whole time, and the material passed through; it was a continuous cycle of operations. If that was practicable—and he believed it was because it had been in operation in the Manchester district during the war period—it was a very obvious addition to any intermittent process such as had just been described. An important matter, not touched upon by Mr. Cook, was the cost of the pots and the life of them, and some information on those points would be helpful. During the last few months a material, composed of iron of some kind, or it might be described as steel mixed with certain metals, had been brought to his notice. Pots made of this had an extremely long life, so much longer than ordinary steel pots, that although the initial cost was higher the gain when taken over a period made it well worth while to use it.

Mr. SIMKISS replied that the pots he used weighed about 1¼ cwt. each. They had to be moderately light on account of the permeation of the heat through to the casting. The section was ½ in. at the top, 5-8 in. at the bottom. These, of course, worked out at 98 heats, they outlasted the steel pots which give 87 heats.

Mr. COOK said he had no experience of muffle furnaces; he was anxious to try them when he got the chance. He came there to speak from a practical standpoint, and not to deal with fine technicalities, and he was glad to see that there were others present who could help any member who went in for annealing.

Mr. KEY remarked that while Mr. Simkiss advocated the use of good material Mr. Cook said he found he got good results with any material. Apparently there was a certain chemical combination which would give the best results, and what that combination was remained to be seen. He should not be prepared to pay a high price for the material represented by the analysis given by Mr. Simkiss.

CONDITIONS OF BLAST IN SMALL BESSEMER CONVERTERS.—A paper in a recent issue of "Stahl and Eisen" describes experiments carried out on two small converter plants for the purpose of obtaining the information mentioned above. These tests appear to have been carried out with scrupulous regard to scientific conditions, and the results may therefore claim to be reliable. The results are given in curves and tables, and are summarised by the author as follows :—(1) From tests made with lateral and underneath inlet of the blast to the blast boxes it was found that the underneath inlet offers considerable advantages with respect to blast consumption, time of blowing, and losses. (2) From experiments carried out with the tuyeres or nozzles arranged in different positions relative to the surface of the bath, it was found that of the five different arrangements tested the most advantageous, from the economic standpoint, was that in which the nozzles were arranged in planes perpendicular to the inner wall. (3) Of the two depths of bath used in the tests (450 and 530 mm.), the greater depth was the better. (4) In all the tests it was found that blast consumption (or time of blowing) and losses are dependent to this extent, that a greater loss is associated with a high blast-consumption or long blowing period, and *vice versa*.

The Testing of Refractory Materials.

In a recent issue of the "Gas Age," a writer describes the extensive laboratories of the Koppers Company in the Melton Institute, Pittsburg. These laboratories are primarily engaged in the investigation of coal and its by-products, but, in addition, a portion is set aside for the study of ceramics.

In these laboratories are investigated refractory materials, brickwork, and masonry, that are of supreme importance in by-product coke oven and gas plant construction. The Ceramics Division of the General Laboratory Organisation has been responsible for the development of certain useful methods for the testing of refractory materials, that have given it a wide reputation. The load-testing furnace for fire-brick developed in these laboratories has been adopted as standard by many firms and organisations. This division has the care and maintenance of all the pyrometer equipment of the Koppers Company, and does important work in high-temperature measurements. The equipment comprises load-test furnaces, fusion-test furnace for clay, brick, etc., fusion-test furnaces for coal and coke ash, equipment for sieve tests and porosity tests, equipment for heat conductivity measurement, expansion measurement, optical and thermo-electrical pyrometers, etc. A museum of specimens of refractory materials is maintained by the division.

The quality of the refractory materials used in the elaborate and massive structures composing the modern by-product coke plant is of supreme importance. The Koppers Company has been frequently called upon to use its unequalled experience in the examination of refractory materials, not only for its own construction work, but also for the information of manufacturers and users of such materials.

They have developed facilities for the accurate determination of the softening point of fire brick and the behaviour of such material under load at high temperature. The results are of the utmost value in by-product coke-oven construction, and are applicable to other forms of refractory construction. This line of work includes the testing of silica brick and minor tests such as determination of porosity and specific gravity, complete analyses, etc.

Standard Tests of Refractories.

A list of the more usual standard tests of various refractory materials is appended herewith :—

Standard Test No.	
	Fire Clay Brick.
31a	—Load test at 1,100 deg. C.
31b	—Load test at 1,300 deg. C.
31c	—Load test at 1,350 deg. C.
32	—Softening Point.
33	—Linear shrinkage on reheating (1,295 deg. C., 1,350 deg. C., 1,425 deg. C.).
42	—Porosity and Permanent Volume on reheating to 1,370 deg. C. or 1,425 deg. C.
35	—Apparent Specific Gravity and Porosity.
36	—Analysis.
	Silica Brick.
41	—Load test at 1,500 deg. C.
42	—Porosity and Permanent Volume on reheating to 1,500 deg. C.
43	—Softening Point.
44	—Porosity and Apparent Specific Gravity.
45	—True Specific Gravity.
46	—Analysis.
	Fire Clay and Refractory Cements.
51	—Softening Point.
52	—Screen Test.
53	—Analysis.
54	—Drying and Burning Shrinkage.

C

Foundry Production, Cost, Management and Selling.

At a meeting of the Coventry Branch of the Institution of British Foundrymen, on November 14, 1919, under the chairmanship of Mr. Andrew Harley (Branch President), short papers were given as follows :—" Production," by F. Pearce; " Costing of Castings," by A. T. Linnett; " Management and Selling," by G. E. Roberts.

PRODUCTION.

By F. Pearce.

Mr. F. Pearce said he would begin by attacking the system responsible for the conditions now prevailing in the foundry. It was seldom necessary to inquire which portion of the works was the foundry, and one never expected to find a more unkempt, draughty, ill-lighted, and dreary place, even if twenty other departments belonged to the same concern. A certain firm extended their foundry into another department which, in winter, was heated by steam; but the connection with the apparatus was cut before the foundry people spent their first winter there. Even those who did not know black sand from soot knew that any old shack was accounted good enough for a foundry. A fair future was before the British foundry trade; but up to the present, generally speaking, conditions in British foundries had not only been unattractive but actually repellant. A man could not make very good moulds if he were frozen. Nor could he enjoy his existence when the broiling sun, together with the internal heat of the foundry, sapped all his vitality, making him as limp as a wet rag.

" Can it be gainsaid," continued the speaker, " that the general dreary dirtiness of the foundry often has a demoralising effect on a man's work or some other phase of his life? What a condemnation to be able to write down the judgment that there is not a tittle in the general conditions of foundry life that can be claimed to be attractive to people looking for a trade." They must have conditions which were new to the foundry, working conditions which would provide for roomy, clean, well-lighted, and well ventilated foundries, where toil and draughtiness, discomfort and squalor were minimised.

Coming next to the question of whether the application of science affected the work in the factory, Mr. Pearce said that very few foundry workers had been interested in the scientific or theoretical side of foundry work. That would not be so in the future, as the foundry worker who now had an opportunity of studying chemistry, metallurgy, and general foundry practice, would have an interest twice as great as the present lover of his craft. The foundry worker should also be able to hope that the application of science would bring him some respite from his arduous toil, some comfort in his work, and some relief from his trouble. Although the foundry worker might be forgiven by reason of his lack of opportunities, this forgiveness could not be extended to the foundry management, who, although forced through the present demand for castings of specific capabilities, were seemingly slow scholars and did not apply with vim scientific knowledge together with their inheritance of practical experience.

Criticising the inertia of foundry managements respecting the question of invention and provision of small tackle, the speaker said that in small foundries that small bit of tackle which was needed was very difficult to get. Looking back over the past ten years, which marked a great advance in the British foundry trade, one could tabulate several sweeping changes in foundry work; but the cut sprig, the gagger, and the chaplet had very few new comrades. Foundrymen were very few who had invented a single piece of small tackle for their own use. At two different foundries castings of the same type were made. In the first foundry at one period about 50 per cent. of the castings were waste, and in the second about 75 per cent. of the total castings were scrapped. The essential thing to have produced them successfully was simply a small nail in the way of a chaplet. In these cases, the identical thing was on the market at the time, though not in general use in foundries. Obviously, this was a matter in which progress was necessary. Another case calling for special treatment was that of moulds needing lifters, or in which many castings were required. There should be sufficient flat box parts in the shop, with bolt holes made in the bars, and projections fitting perfectly bolted on. Such contrivances would save the moulder an enormous amount of work, as there would be no necessity for sorting out or placing in of lifters, and no fastening and tightening of grids. Efficiency in the foundry would depend a great deal on the way in which the provision of small tackle was dealt with.

He regretted to have to speak of the laxity, carelessness, and inefficiency of the moulder, which were responsible for the making of much scrap, and the production of many imperfect and inferior castings. Hurry was the fruitful cause of waste castings, and unfortunately every moulder did not take a delight in his craft and, therefore, did not apply himself with zeal to his work. It must be added, however, that a jaded, used-up moulder was obviously not the most efficient of craftsmen.

There were various essentials required to increase the efficiency of the foundry worker. If he were employed in making castings for motor cars he should receive theoretical instruction, and have an opportunity of witnessing motor engines in actual working. That principle, however, should be applied as far as possible in the case of all those who had to do with the making of castings.

To all this should be added the opportunity of acquiring a sound knowledge of chemistry and metallurgy, with a comprehensive study of past and present foundry practice. In this way better foundry workers would be produced, with the result that production would eventually become efficient.

COSTING OF CASTINGS.

By A. T. Linnett.

Mr. A. T. Linnett treated in some detail with the economical aspect of the question, pointing out that the basis of all value or price was labour, value or price being merely terms expressing the amount of service exchangeable for the particular

commodity produced; and the most successful business was the one producing the greatest amount of a given exchangeable commodity with the least possible effort or labour. In other words, when a marketable commodity is produced which can be exchanged for service in a greater degree than the value of service put into it, the business may be said to be successful.

Profit, the speaker remarked, was the incentive which vitalised industry. Profit was essential to give happiness to the workers, to provide suitable recreation, better conditions of life and insurance against a "rainy day," and profit could be materially increased by greater efficiency, wider knowledge and adaptability. On the other hand, by bad management or organisation profits might be extinguished; yet the cause of failure was not often realised.

Profit, the speaker further defined, as the excess which allowed for the installation of better methods, up-to-date tools and appliances, necessary extensions, and such a return on the capital as would attract other capital. To this end there must be methods of procedure and discipline, and the formation of departments ensuring necessary control and the regulation of energy, while the collection of records should give full knowledge of the working result.

"When these regulating departments are carefully co-ordinated and the team spirit pervades them all, from the highest official to the humblest worker, success is assured, distrust will be banished, a wholehearted co-operation of effort will exist towards a common goal, that of high efficiency with complete concord. Although profit-making may be primarily aimed at, beyond this there is a disposition all round to improve conditions of work and existence, that life may be fuller for every individual."

The speaker emphasised the great importance of costing in its relation to profit, particularly for large establishments, and quoted Lord Weir as stating that wholly insufficient stress had been laid upon the importance of the duty falling upon an employer of providing a good costing system. Lord Weir added that "the revision of methods, the problems of remuneration, and the intelligent initiation of good methods are impossible of realisation without the searching and discriminating light of accurate cost figures." He (Mr. Linnett) believed that the great advance made in the production of war material was largely due to the increased efficiency of costing systems, the value of which was recognised by, and its working supervised by the Ministry of Munitions.

The function of the Costing Department the speaker defined as the collection of all data necessary to ascertain the actual value of any commodity manufactured, in terms of goods and material purchased for manufacturing purposes, and the labour necessary to transform the raw material into the finished product. Up to a point costing might be regarded as a very simple operation comprising the mere mechanical handling of figures. But to be valuable sound technical knowledge was essential, especially when estimating was included in the duties of a department.

The company he was connected with manufactured motor-cars, and it was essential that the car should be offered at a price which would induce purchase, although efficiency and appearance considerably assisted the sale. Some arbitrary figure or value might be fixed allowing neither profit nor a just reward for labour, or even sufficient to cover the cost of the necessary material. They must, therefore, have full and accurate knowledge, first of all with regard to the material, and, secondly of all the operations for the production of the car. Knowing these the selling value could be fixed with safety and confidence. Probably, most people never realised that the distinct pieces entering into the construction of the motor-car were many thousands in number, while the variety of the materials came from the animal, vegetable and mineral kingdoms each bearing the impress of human thought and effort. It was necessary to tabulate and take account of the labour expended directly in shaping and assembling all these pieces. The combination of such direct material and labour was termed the prime cost. The speaker compared the actual or complete cost to a triangular figure, two sides of which should consist of direct material and labour. Having worked these out they had to find the value of the third side of the triangle before making their final reckoning of the full cost. To the third side of the triangle should be allotted a portion of all the expenses of running the business, in labour and material not directly chargeable to the commodity produced. That share of the cost was usually termed the overhead charge. Obviously, the overhead charge varied in proportion to productivity,, and it would be realised, therefore, how necessary it became to secure a high output, in order to keep the proportion as low as possible consistently with good management.

Dealing specially with the foundry, the speaker remarked that although in theory the same principles were applicable, yet in actual practice the methods had to be considerably modified. In the manufacture of a motor-car, track of nearly the whole of the material used could be kept from its entry to the works to its place in the finished product, and the same might be said of the labour dealing with the material. Thus with reasonable care and foresight very accurate results could be obtained in arriving at the cost figure; but the foundry was a very different proposition. He read a few days ago a statement by an engineering expert who said: "There is probably no part of an engineering works which gives so much trouble and so much anxiety as the foundry, and when costs are considered views differ so widely as to methods that one can find no uniformity anywhere."

Unlike other departments the foundry had a heavy item to add to material, usually described as sundries or process materials such as sand, coke, gas and other materials not directly entering into any article produced, and which could not be allocated to any job it was used upon. Similarly, a large proportion of the labour in the foundry such as that of furnacemen and sand mixers could not be directly charged, and where the product was of a mixed nature the problem became still more difficult.

"As far as my judgment goes, the most practical way to arrive at any satisfactory basis of foundry costs is to first estimate the weight value, for which practical knowledge of foundry work is an essential qualification, and then charge accordingly. The total amount of the sales can be taken as the output, and by carefully recording all material coming into the foundry, and the labour used therein and preparing from this data a monthly balance sheet, a good knowledge of the progress will be obtained, and gradually a reasonably correct scale of charges will be arrived at, which can be

modified as the result of experience gained, and in this way successful working conditions will be assured. After a time, this balance sheet can be made to cover a longer period, but in that case care will have to be exercised to observe all fluctuations in purchase and labour values and allowances made accordingly. If this is done regularly, indications fixing the value of different methods can be seen and compared, and the various departments suitably regulated."

In conclusion, the speaker emphasised the necessity of unity of effort and harmonious co-operation by all concerned as an essential to success.

FOUNDRY MANAGEMENT AND SELLING.

By G. E. Roberts.

This subject is so wide in its scope that the writer can only touch on a few of the important items connected therewith, and give a few details with regard to the difficulties which one may expect to encounter.

In a large foundry, of course, all inquiries are sent to the estimating department for attention, but in a small factory this work of necessity falls on the manager. In any case, it is advisable for the manager to make a close examination of all quotations before they are sent out, and to scrutinise them in the light of the very latest foundry costs, not overlooking any particular trouble, manufacturing or otherwise, going on in the foundry, especially the relation of scrap to output. It will be often found that the loss through scrap castings makes all the difference at the end of the financial year between a useful profit and an unpleasant loss.

In the case of many inquiries, only the vaguest possible information of what is required is supplied; oftentimes no clue is given to the class, size or weight of casting required, and trouble will certainly overtake anyone who attempts to deal with such inquiries without fuller information, as even if an average price is quoted a client is always disappointed if he be asked to pay more when his patterns are found to be different to those which the foundry expected. On the other hand, where an easy job is offered the firm or person requiring the castings is usually shrewd enough to know that such is the case, and consequently supplies the information which will ensure a keen and competitive price.

Then, again, it is not always prudent to quote to a blueprint or drawing, especially if applicant for prices states that patterns will be supplied, as frequently such patterns but feebly resemble the drawings from which they are made, and more frequently still are quite unsuitable for quick production, which is the second essential of successful foundry trading, first-class castings being the prime consideration.

In these circumstances, therefore, the wide-awake salesman will safeguard the interest he represents by endeavouring to get an opportunity of making one or more trial castings off a difficult pattern, noting the manufacturing cost carefully, taking into consideration the percentage of likely scrap and quoting for quantities according to the experience gathered on the trial job. Many firms handle inquiries in this way when they are in the least doubtful as to how a job is likely to turn out as regards cost of manufacture.

If but one or only a few castings are needed off a difficult pattern, I think it is well to diplomatically refuse to give a definite price, but offer to accept the job at a percentage on cost. Generally speaking, it is sound policy to steer clear of orders for odd jobs of such a character as that indicated above, if immediate profit be the chief consideration, for the simple reason that jobbing foundries as such are rarely successful as profit making concerns, until the loss on jobbing work, which is fairly general, is compensated for by the profit made on repetition work, when of course a foundry ceases to be a strictly jobbing shop. To get in with a firm whose work is desired it is sometimes necessary to take the risk of loss on first transactions, but the general principles set forth above holds good.

As a further precaution against loss when quoting, it has become necessary, as is generally known, to insert what may be termed a saving clause, by which the right to amend any price may be reserved, should the cost of labour or raw materials justify it. I am discussing these matters from the sellers' point of view, and although some of these points may seem somewhat unreasonable, yet they are not generally unacceptable to the buyer, who is, as a rule, familiar with the difficulties of quoting fixed prices when labour charges are uncertain, and the market for raw materials is equally unstable.

It may not be out of place here to put forward a plea for closer co-operation between designer, pattern-maker and foundryman. Experience has a thousand times proved that many attractive designs are committed to paper and even pass the pattern-maker, but which are almost impracticable in the foundry because of moulding, or more often of casting and cooling difficulties. The average designer, erroneously in my opinion, too frequently studies the wishes of the machinists and overlooks the difficulties of the foundryman.

It can be truly stated that large sums of money are wasted annually in attempting to work difficult patterns which would never see the inside of a foundry if the foundry manager had had an opportunity of criticising designs from the foundry standpoint. This arrangement would afford the additional advantage of bringing into general use designs which would not only be practicable, but which would accelerate production, thereby reducing working costs, besides cutting out waste. It is to the credit of the Air Board that in the latter days of the war they made a real effort to reduce difficulties in the foundry by instituting a system of collaboration between designer, pattern-maker and foundryman before finally placing designs for actual production in the hands of the pattern-maker, thus eliminating many troubles which otherwise would not have been located until after trial and error in the foundry.

The next pitfall of which the sales manager should be wary is that of the delivery question. Time quoted for delivery is often the deciding factor in the placing of an order, and the careful salesman will usually strike a balance between the time it will actually take his firm to deliver the goods, and the minimum time his competitors would specify for delivery. It is always a good rule not to promise better than one can fulfil, for human nature is such that a buyer invariably seems to remember when he is let down on delivery, even though he fails to recollect when a delivery promise is adhered to or even improved upon.

All delivery dates should be carefully considered in conjunction with the production department.

as this precaution must make for smooth working. It should be a cardinal principle to so co-ordinate all departments that confusion may be reduced to a minimum, and so that responsibility may be localised in the event of failure to keep delivery promises.

Having proceeded thus far in the direction of quoting prices, obtaining orders and securing the patterns ready for work, it may be useful to consider the necessity of making trial castings before proceeding in bulk. This is particularly necessary in the founding of some metals, as the results of pouring, feeding and contraction, etc., of some castings and metals are very often uncertain, and a lot of scrap work may be avoided by resorting to the expedient of making trial castings. Another point in this connection is the necessity of reducing the fettling or dressing required to finish castings ready for delivery, and this, of course, must be taken into account in the gates and feeding heads. In some cases it is possible to reduce the fettling to an almost negligible amount by a little forethought in the direction of careful gateing; on the other hand, it may be found quite difficult to produce sound castings without a troublesome amount of dressing when the castings are otherwise ready for despatch. And for these and similar reasons trial boxes are a safeguard against waste and help towards economy of production.

One must not overlook the social and welfare side of factory organisation to-day. A great step forward has been made in the last four or five years, but we are still a considerable way from the ideal. It is not enough for the employer to provide canteens, playing fields, etc. There must be the personal participation in the pleasures and recreations of his fellow workers. This would provide the human touch which is absent from industrial life to-day. The way to mutual understanding is through mutual knowledge. It is not enough to know the man at work or the employer in the office. They must meet on more common ground, where each can more readily sink his identity and work or play together for mutual profit, development and pleasure. This may sound too Utopian when placed against the realities of to-day, but we must dream dreams and see visions if present conditions are to give place to something better, bearing in mind that the dreams of to-day become the realities of to-morrow.

There are illimitable opportunities in foundry management for work such as I have indicated, and the successful foundry of the future will prove to be the one where selfishness ceases to be the keynote of every activity, and where the well being of the bodily and the recreative side of the employee occupies a high place in the thoughts of the management.

We may now turn to the development of the selling side of the business. The first essential is to gain a reputation, either for quality or cheapness. It cannot be too often stated that the former is the most direct road to success, especially when it is borne in mind that there is more competition to secure business on price than on quality. I therefore plump for the article of quality. It is, of course, necessary to carefully allocate the amount of money that is available for sales development and act accordingly. It may be possible to allocate sufficient for thorough representation and advertising, or there may only be sufficient allowance to employ an agent on commission without any allowance for expenses. These items of expenditure require very careful thought, as it would be disastrous, of course, to employ an expensive and exclusive traveller touring the country if the factory output was but small. Then, again, there must be given consideration to the class of business required. Perhaps a firm will wish to build up a big local business in a centre like Coventry where there is plenty of scope; or, on the other hand, it may be desirous of looking outside its own district for the business it seeks to do. It is impossible to lay down hard and fast rules in a matter of this sort. It is a matter of policy to be determined according to differing circumstances.

Speaking generally, a foundry business is best developed by placing its representation in the hands of a thoroughly live and active commission agent, and granting an agency for a given district, always being careful not to give any representative an area larger than he can work efficiently. It is a really expensive business to employ an exclusive travelling representative in these days, and where representative agencies are granted one usually only pays for the value of orders received and executed, being careful in all such cases to make an arrangement to deduct the value of all bad debts made by opening bad accounts, which is sometimes done by keen men whose zeal for orders outruns their discretion regarding the financial strength of the people from whom they accept orders.

One is doomed to disappointment if they expect too early a crop of orders from agents, and such being the case it will be usually found that such a representative will require the agency to be left in his hands for a period of years if the first year's turnover realises a certain predetermined figure, so that the agency may not be withdrawn after the spadework has been done. After a few years it is naturally a serious matter to change agents, as the manufacturer may find it difficult to retain the business which has been secured by the commission agent; and, on the other hand, the agent may not find it easy to switch his customers on to another manufacturer if the goods delivered by the firm previously represented have been up to requirements.

Another phase of the selling campaign is that of advertising, and perhaps in no other department of expenditure is it more easy to waste money. The reason, I think, is because it is so difficult to check results. One can pay a travelling representative and check the amount of business he brings, but one cannot check the return which advertising brings. It is, therefore, most important that particular care be given to this expenditure. Perhaps one or two guiding principles may be useful. For the purpose of advertising castings, I think paper advertising in the technical press is the most effective, but here again it may be necessary to narrow these down. The thing to ascertain, as far as is possible, is the medium which reaches the largest number of people exclusively interested in the article you have to sell. Indiscriminate pamphlet advertising also is wasteful, although I do believe in the use of tasteful brochures when replying to inquiries for castings.

Finally, the writer would remark on the necessity of tidiness and cleanliness, even in a foundry. One writer has said that " Where thou findest disorder, there is thine eternal enemy," and this is especially true in the foundry.

There are many other matters of moment which should receive the attention of the foundry manager—such matters as storage of patterns, the relation of piecework to daywork output, the proportion of stock to output, the compilation of

records and such matters, which all make for efficiency. While it is possible to be over-organised and spend money out of proportion to output on such things, it cannot be over-emphasised that success is based on knowing what is being done; or, to put it in the form of an old proverb, "Knowledge is Power."

Discussion.

The CHAIRMAN pointed out the difficulty of obtaining exact figures where the output was of great variety, and where, as at the Daimler Works, a variety of metals was dealt with in one large shop. In considering general principles, he was firmly of the opinion that in arriving at the purely foundry cost, the foundry overhead charges should be subdivided in the following way:—All indirect labour should be a percentage on the direct labour, the latter consisting using of moulding, core-making and fettling charges. Material should be treated separately, but on the same lines. Direct material would consist of the metal entering into the casting, and indirect material would consist of all other materials which were required for the conversion of the direct material into a casting, and would form a percentage on the direct material cost. The foregoing would constitute what might be termed the purely foundry cost. He understood Mr. Linnet to say that the best method of obtaining costs was to get the weight value by constructing a balance-sheet periodically, and make corrections according to the information thus obtained. Such manufacturing accounts were very useful, if not essential, but did not furnish the costs of individual castings. Such individual costs were very necessary. He was referring particularly to the class of work produced in the Coventry district. If this were not possible the output should be carefully graded into classes, and the price per lb. or per piece in each class obtained. The classification of the castings should be as narrow as possible, as in that case the cost in each grade would approximate more to the cost of individual patterns in that grade. With regard to the malleable trade, the custom of charging so much per lb. was general. This system of averaging cost was not satisfactory, and it would be much better if malleable founders were able to grade their prices according to the character of the work done, but this could only be accomplished by having a more detailed and exact costing system.

With regard to Mr. Roberts' paper, he (the speaker) agreed with almost everything that had been said, and he thought that side of the question had been treated in a very satisfactory way. Mr. Pearce's paper was also very much to the point. They all agreed that foundry conditions ought to be the best possible, whereas in many foundries it was absolutely bad. He thought the Institution could do something by advocating reforms in that direction. This was a matter which should have the attention of all concerned. Men could not be expected to work well under disagreeable conditions, and the establishment of good conditions was, therefore, a sound business proposition. Then with regard to the question of foundry tackle, to which Mr. Pearce had referred, he was always in favour of the best equipment possible; for example, money was never wasted in providing suitable and accurate box plant. Good castings could not be produced regularly with make-shift tackle, but this policy was much too common in many foundries.

Mr. HILL said that a remarkable statement by Mr. Roberts was that almost invariably, the jobbing foundry did not pay, and that they had to rely upon repetition work to show a profit at the end of the year. If that was so he would like to know what would happen to the jobbing foundry which never took any repetition work. He knew some foundries certainly who had always shown a very satisfactory balance.

The CHAIRMAN said the common sense of the matter was that, generally speaking, jobbing work usually obtained a higher price than repetition work. Such jobs could not be dealt with by repetition methods, and the cost of production was naturally higher. Jobbing founders, of course, made a profit as a rule; and, as a matter of fact, those engaged on urgent repair work usually make very good profits, as the price charged was not in such cases the main consideration.

Mr. DIGGER expressed some disappointment with regard to the paper on the costing of castings, and thought Mr. Linnett had not touched on the subject very much. Personally he would like to know a good deal more about it. Mr. Pearce in his paper had stated that the moulder was not always blameless when bad work was produced. He (the speaker) thought that could be got over, and he would like to know, in the event of the moulder being prepared to institute any new methods, whether he would get the consideration that was desirable. Personally he did not think much consideration would be extended to him, and he thought this was one of the biggest drawbacks to-day. If it were true, as has been stated, that the moulder did not take sufficient interest in his work, the reasons were to be found in the conditions of the foundry, which very often were not what they ought to be.

MR. B. WILDING pointed out that there was plenty of evidence that the Home Office were getting alive to the bad conditions connected with foundry work prior to the outbreak of the war. They might possibly remember that in 1912 or 1913 Mr. Bellhouse, on behalf of the Home Office, made an investigation of the foundries and published a report dealing specially with foundries in regard to lighting and other matters affecting health and accidents. In that report certain statements were made and certain facts published which must have brought home very forcibly to the foundry proprietor and the foundry manager the desirability of maintaining a good standard of lighting and a good standard of cleanliness in the foundry. The report also gave figures and examples taken from good and bad foundries. Some foundries showed natural lighting value of 100 per cent. of the floor area and some came down to a very poor percentage, although he could not remember the exact figure. The same applied to artificial lighting, and in that matter some of them showed almost entire absence of light. The report emphasised the desirability of giving a good floor light as a means of preventng accident.

MR. LINNETT, replying to some remarks on the question of the fixing of foundry costs, said that after he had drafted out the general outline of his Paper he had endeavoured to get all the general expert knowledge he could on the question of costs. He found that practically all the men who wrote on the question, and some of them were eminent experts, started with something of a premise as to what a year's output and a year's expenses would be. That appeared to be an invariable starting-point. He had looked up the matter for about ten years, and he found very little variation. The Chairman had mentioned a certain line he would

take in his foundry if he were to control it in his own way. He (the speaker) might tell them exactly what they did at the Rover Company. They were in the habit of dividing their direct and indirect charges as to the material, and that was done at the office. They had every invoice which came to the Rover Company sent to the office, and all of them came under his (the speaker's) direct notice, and this also applied to labour charges. Where they bought indirect material, such as coke or sand, if it were for the foundry it would be marked "Foundry process material." In other words, that would be foundry indirect material, so that they split the foundry overhead charge into two parts, and they got the direct charge and the indirect material. Then they got the overhead charge, which they fixed by experiment from experience gained. With regard to dealing with the value of material, they split that up in the way he (the Chairman) suggested. The costs of cast-iron would be put into seven or eight different grades with the particulars for each grade. Cylinders would be in the highest grade, but there would be varying grades down to furnace bars, fire-plates, and things like that. When they dealt with non-ferrous work, such as aluminium, intricate castings would be put in the highest grade, whereas plain castings which did not require much labour in making would be put in the lowest grade. They were in the habit of making up a balance-sheet every four months, and by that means they discovered where their prices were in need of modification, and they modified them according to the extent of fluctuation. They found that they were reasonably correct, and he believed that that came as near accuracy in their foundry estimates and calculations as it was possible to be.

SHEFFIELD BRANCH.

Ambergate Meeting of Foundrymen.

A very successful and enjoyable meeting of the Sheffield and East Midland Branches of the Institution of British Foundrymen took place on Saturday, October 25, at Ambergate. During the afternoon the members visited the Clay Cross, Limited, Works and also the Midland Refractories, Limited, Works. Mr. Greenfield, managing director of the latter company, extended a hearty welcome to the party, and the works were inspected in detail. The party was afterwards entertained to tea. After tea Mr. Goddard gave an interesting Paper on "The Manufacture of Refractory Materials." Dr. Hatfield was in the chair. The Paper was as follows:—

The Manufacture of Refractory Materials.

The manufacture of refractory materials is a subject to which all practical foundrymen might give a good deal of careful consideration, with beneficial results to themselves, their trade, and their customers. Incidentally, by considering the matter a little more deeply than has been the case in the past, it would be possible for them to make matters a great deal easier for the manufacturer.

The subject is a very wide one, and I propose, therefore, to confine my remarks to those materials which are produced at the works you have visited this afternoon.

First of all, there is *Ground Ganister*. Every foundryman, whether steel, iron or non-ferrous, uses, or should use, ganister for lining his furnaces. If there were one standard to which we manufacturers could work and which would satisfy all the foundry proprietors and their men, then our work would be indeed simple. The trouble is that there is no standard, and in practice material which suits one firm is considered by another to be quite unsuitable. It is in this respect that users can be helpful; and if, for example, when ordering ganister, they would indicate either the exact purpose for which it is to be used, or say that it was preferred very coarse, coarse, fine, or very fine, and whether it should be extra sticky or not very sticky, or what its characteristic should be, manufacturers would do their level best to deliver the right goods. The usual thing is to order just "a wagon of ground ganister" with no indication of the grade required or the use to which it is to be put.

At our own works, we are particularly fortunate in having close at hand abundant supplies of excellent ganister rock and fireclay. Both of these materials are mined by our own men, and are regularly analysed and tested so that we may maintain a uniform quality of ground ganister. The rock is first put through the stonebreaker and is conveyed mechanically to the mill, and the requisite quantity of fireclay and water added. The addition of the fireclay is not merely guesswork, but is based actually upon our experience of the particular user's requirements. Exact record is made of the mixtures which best suit the particular work of our various friends and, in short, everything possible is done to supply a satisfactory product. The actual grinding of ganister presents no great difficulties, but care must be taken that the mixture remains in the mill just the length of time necessary to produce the degree of fineness required.

Silica Bricks.—The manufacture of silica bricks is a very much more complex proposition, and there are a great number of vital factors to be considered and carefully watched. In this important branch of the trade manufacturers have a standard to which they can work, and the research work which has been recently carried out by such Institutions as the Sheffield University (Refractories Department), the Ceramic Society (Refractories Section) and several eminent French scientists, have been of material assistance to all. For ourselves, we cheerfully acknowledge our great indebtedness to Mr. W. J. Rees, of the Sheffield University Refractories Section, whose painstaking investigations and helpful suggestions have very materially helped us to produce high-grade silica bricks for the roofs of electric furnaces.

It can be argued that it needed a world-wide war to induce manufacturers to adopt the scientific methods of making silica bricks, which are now, or should be, the basis of all up-to-date brickworks practice. In defence, however, it may be said that the same world-wide war was required to induce the users of silica bricks to state what the conditions of service of the bricks actually were, and wherein the pre-war bricks supplied failed to meet these conditions.

The method of manufacture of silica bricks at our works is as follows:—First of all, the silica rock, or ganister, is most carefully selected, of uniform quality and grade. The rock is first crushed by the stonebreaker and the mill; it is then passed into a solid-bottom mill, where the mixture with lime takes place, the whole of the crushing and grinding operations being so conducted as to give a properly-graded mixture. The addition of lime to the

ground silica is a matter which requires the most particular care; too much lime or too little would spoil the brick. The lime, which is added in the form of lime putty, is measured exactly, and the mixture ground for a few minutes to ensure thorough mixing.

After leaving the solid-bottom pan, the material is ready to be made into bricks. It is conveyed to the brickmaker's table, and is trodden and tempered by a man, who also forms it into rough rectangular clods, containing just about sufficient to make two bricks. The clods are then moulded into the required shape by the brickmaker in his double moulds. When moulded, the bricks are placed on the drying floor, and the next process is that of setting in the kiln and burning. The bricks are usually set in the kiln on their ends, and again great care must be taken to allow for the expansion which takes place when burning. Silica bricks expand about ¼-in. in 8¾ in., and 9 in. bricks are thus made 8¾ in.

The subject of burning silica bricks is one over which there has been a good deal of controversy, and, though intensely interesting, cannot be dealt with here, as it is really worthy of a Paper and discussion entirely on its own.

We use the ordinary beehive or round kilns, and we consider that the extra cost of fuel used when compared with gas-fired kilns is, after all, only a minor consideration. The temperature of burning our bricks is regulated by the use of thermoscope bars. We invariably burn to bar No. 35, indicating a temperature of 1,475 deg. Centigrade. The cooling kilns is also a matter which requires care, as if they are opened out too early the bricks will crack and sinter.

Magnesite bricks are made in a somewhat similar manner to silica bricks, with the exception that the bond used is iron oxide instead of lime. The raw material is, of course, imported, and as received is a carbonate of magnesium; therefore, before the material can be made into bricks it is necessary to eliminate the carbondioxide. The material is therefore, burned or roasted in the kilns until completely shrunk or dead burnt. The usual methods of brickmaking are then proceeded with.

Ground fireclay and silica cement are just carefully ground materials, and their manufacture is similar to that of ground ganister. In the case of silica cement, however, only highly silicious stone with the addition of a small quantity of carefully selected refractory plastic fireclay is used, and the material is ground either dry or wet, as best suits the users' requirements.

Discussion.

Mr. Pemberton, in opening the discussion, asked Mr. Goddard to state, if he could, the respective lives of silica and ganister bricks.

Mr. Rees (Sheffield University) considered that insufficient care was, generally speaking, given to the heat-treatment of silica bricks. He also pointed out that if the material is heated too rapidly the allotropic changes so essential to the production of good silica bricks had not time to suitably take place.

Mr. Bolsover (of Sheffield) thought that the refractory materials people could learn much by studying some of the efficient types of furnace which were now in operation for different treatments in steelworks.

Dr. Hatfield wished that more such meetings of the different branches could be arranged. The afternoon had been entirely successful, both from the works visits standpoint and also as regards the discussion which had taken place.

SCOTTISH BRANCH.

A meeting of the Scottish Branch was held on Saturday, November 15, 1919, when a Paper on "Foundry Facings" was read by Mr. H. Winterton. Mr. William Bell (Branch President) occupied the chair.

Mr. Winterton, at the outset, stated that, although the question of facings was a subject of the greatest importance, it had little attention given to it by the average foundryman. He continued :—

Foundry facings are usually divided into three classes, namely, coaldust, blackings, and steel refractories. In many foundries the question of facings is now receiving special consideration, and the mixing is being performed with the same degree of accuracy which is now being directed to the mixing of irons for special purposes.

The selection of a suitable coal is one of the first cares to be observed in the production of coaldust. Consideration must be given to the bituminous properties of the coal, also its ash content, the volatile matter and the proportion of fixed carbon which it contains. The object of introducing coaldust near the face of the mould is to produce a layer of gas between the liquid metal and the sand, which acts as a buffer and prevents the molten metal from getting into actual contact with the mould. Care must be observed in the use of coaldust that the gases generated should not be overpowering. The strength of the coaldust should be regulated according to the thickness of the casting, if a facing sand contains too high a proportion of coaldust an excessive amount of gas is produced and penetrates into the casting, causing the surface of the casting to be pitted. When selecting a coal from which coaldust is to be produced, care must be observed that the coal should contain certain properties so that the coaldust made from it will perform its proper functions. Coaldust is not used as a refractory, therefore it need not be too high in carbon, a high percentage of ash is not an objectionable feature in coaldust.

The lecturer stated that he had seen a coal used in the form of coaldust containing 25 per cent. of ash, and gave satisfactory results. The lecturer advocated a variation in the grit of the coaldust for different classes of work. The following facing sand mixtures were given :—

Heavy Greensand Work.—55 parts old sand, 30 parts new sand, 15 parts coaldust.

For Light Greensand Work.—70 parts old sand, 25 parts new sand, 5 parts coaldust.

The object of all foundry facings is to prevent the metal fusing with the sand forming the mould, in the case of coaldust the preventive is gas, with blackings it is the material itself.

Blackings must, therefore, contain a high percentage of carbon to give it the refractory properties necessary, and substances such as plumbago, blacklead, graphite, coke, coal, and charcoal, are very suitable. Not only must a blacking act as a refractory, but it must also have sufficient adhesive properties to withstand the wash of the liquid metal, and not easily be rubbed off the dried mould or core.

Many materials are to be found which have the necessary refractory properties to make them suitable for blackings, but they lack adhesiveness, this

latter property is now obtained by the addition of other materials, and the resultant mixture is found to be quite suitable for many classes of work, and can be sold at less cost than other materials, such as plumbago, which possesses all the properties of an ideal facing.

The lecturer then made some reference to the question of steel refractories. Mention was made of the difficulty experienced during the war in procuring some of the materials formerly used for this purpose, and this led to investigations being made with regard to some of our home products, with the result that it was found that some of our home materials could produce as good, if not better, results. The facings and paints used in steel work were used for the same purpose as facings and blackwash in iron foundries, the only difference being that steel called for materials very high in silica.

A number of questions were answered at the close and the lecturer was thanked and accorded a hearty vote of thanks for his most interesting and instructive lecture.

BIRMINGHAM BRANCH.

Annual Dinner.

The holding of an annual dinner, suspended during the war, is to be resumed by the Birmingham Branch of the Institution of British Foundrymen. As far as the arrangements have been carried out the dinner, which will take place on January 7, promises to be one of the most notable functions in the history of the Branch. Mr. H. L. Reason (President of the Branch) will take the chair, and amongst the guests will be Sir Herbert Austin, M.P., the President of the Institution of British Foundrymen (Mr. John Little) Mr. Oliver Stubbs (Vice-President), Mr. Pitts (President of the London Branch), Dr. Hatfield (President of the Sheffield Branch), Mr. A. Harley (President of the Coventry Branch), and probably officers of other Branches. Representatives of the various technical societies of the district will also be present.

Messrs. J. Samuel White & Company, Limited, the well-known shipbuilders and engineers of East Cowes, Isle of Wight, completed and delivered their 120th steel war vessel and 72nd steel torpedo craft on December 23. This was H.M.S. "Wivern," of the improved "W" class, and was laid down on August 19, 1918, and launched on April 15, 1919. She is of 1,450 tons displacement and 28,000 s.h.p. In her steam trials off the south coast of the Isle of Wight she attained an average speed of between 34 and 35 knots. The "Wivern's" twin screws are driven by a double set of Brown-Curtis geared turbines made by Messrs. White, and Mitchell thrust blocks have been installed. Steam is generated in three White-Forster water-tube boilers, each developing over 9,000 shaft horse power. These, together with the oil-fuel installations, all auxiliary machinery, and the entire equipment have also been constructed in the firm's engine works. The ship is capable of carrying some 400 tons of oil fuel, which will enable her to run about 1,000 miles at full speed. Like the other destroyers of her class, the "Wivern's" armament consists of superimposed 4.7-in. guns fore and aft, with fire control and director gear, two anti-aircraft high-angle quick-firing guns on an elevated platform amidships, and two sets of triple torpedo tubes mounted on revolving platforms. As is customary with all White-built destroyers, the living accommodation for officers and crew surpasses that of most destroyers, the firm having consistently made this a special feature of their construction.

Gallenkamp Electric Furnaces.

Electric heat is produced in the Gallenkamp furnace by passing a current of electricity through a resistor of special high resistance wire surrounding the space to be heated, and is proportional to the square of the current strength and the resistance, and is therefore quite under the control of the user.

The maximum temperature is 1,000 deg. C., the life of the heating coil should be at least 1,000 hours,

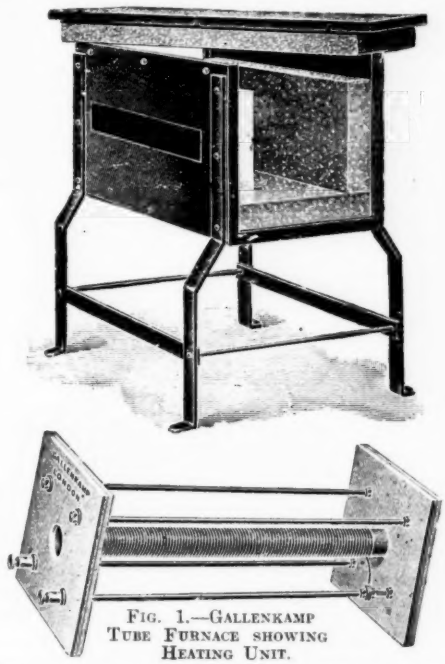


FIG. 1.—GALLENKAMP TUBE FURNACE SHOWING HEATING UNIT.

although in practice careful use has resulted in longer life. However, working at temperatures lower than the maximum rated prolongs the life considerably.

Details of a tube-furnace construction are shown in Fig. 1. The heating unit wound with the heating coil is fixed in the frame and connection made from the coil to the two bottom tie-rods. The frame slides into the casing, which is lined with lagging bricks. The space between the lagging bricks is packed with insulating material. In the tube furnaces, access to the interior of the tube can be made at both ends through orifices in the end walls. In the crucible furnaces, the bottom is closed, and the top is furnished with a fire-clay cover.

The muffle furnaces are closed at one end by a sliding door, which can be adjusted to give any size opening, the other end is furnished with a chimney carrying a baffle plate, thus permitting of regulation of draught through furnace.

Amongst the advantages claimed for these furnaces are :—Low initial cost, long life, and low power consumption; the rapidity with which they can be taken to pieces for renewals, and their cleanliness and portability render them much superior to gas furnaces in this respect.

In addition there are no fumes, the temperature is uniform, and temperature control perfect.

The Gallenkamp furnace has been designed for laboratory and small industrial heating with a view to reducing the cost to within reasonable limits, and to place in the hands of the operator a really useful and durable tool.

XUM

High Temperature Measurements and Refractory Materials.*

At a recent meeting of the Franklin Institute a Paper was presented by C. W. Kanolt, Ph.D., of the Bureau of Standards, Washington, in which he dealt with high-temperature measurements and refractory materials. We give the following extracts :—Before we consider the measurement of high temperatures, it is important to know just what is meant by temperature. If we start with the merely qualitative conception of temperature that we obtain through our senses we may form a satisfactory quantitative definition if we employ the observation that, in the words of Clausius, "it is impossible for a self-acting machine, unaided by any external agency, to convey heat from one body to another at a higher temperature." By the employment of this principle, and that of the conservation of energy, it has been demonstrated that in any reversible cyclic process operating between T_1, and a lower temperature, T_2, the ratio $\frac{Q_1}{Q_2}$ of the quantity of heat absorbed at the higher temperature to that given out at the lower depends only upon T_1 and T_2. Lord Kelvin has proposed that absolute temperature be so defined that

$$\frac{Q_1}{Q_2} = \frac{T_1}{T_2}$$

This is a single equation involving two temperatures, and to make the definition complete, we specify arbitrarily that the difference between the boiling point of water under a pressure of one standard atmosphere and the freezing point shall be 100 deg. This gives us the absolute temperature in centigrade degrees, while the ordinary centigrade scale in which the freezing point is taken arbitrarily as zero differs from the absolute scale by the difference between the absolute zero and the freezing point, which is 273 deg. C.

The definition here presented employs the conception of a reversible thermodynamic process. The restriction to a "reversible" process is important. By this is meant a process the direction of which can be reversed by infinitesimal changes in the applied forces. For example, if a gas were compressed in a cylinder and there were no transfer of heat to or from the gas and friction could be eliminated, the force applied to the piston to produce slow compression would need to be only infinitesimally more than the resisting force exerted by the gas at that particular stage in the compression, and an infinitesimal diminution in applied force would be sufficient to reverse the action at that stage.

Our definition of temperature does not apply to a flame; a flame has no temperature. This fact, which is not always realised, illustrates the importance of the careful consideration of definitions, and is one reason why I have discussed the definition here. Perhaps some other definition of temperature could be formed which would be applicable to a flame, but I am not aware that any consistent one has been developed. We may think of the temperature of the flame as the temperature which a solid object placed in it will acquire; but this temperature depends upon various conditions, including the loss of heat from the solid by conduction and radiation, and even if we can prevent such loss of heat it depends upon the nature of the solid, for the solid may have a marked influence upon the rate of combustion, and probably has some influence in any case. When a flame contains solid particles of carbon, as a yellow gas flame does, these solid particles have a temperature and it can be measured, but it does not represent the temperature of the gaseous part of the flame. For practical purposes we do not want to know the real temperatures of flames, but only that which they will impart to solids or liquids, and this, of course, can be determined, but it depends upon conditions.

The definition of temperature which has been presented, which may be called the thermodynamic definition, is equivalent to that in terms of the expansion of an ideal gas, that is, one in which the product of pressure and volume is proportional to absolute temperature, and which does not change temperature when it expands without doing work. No such gas exists, but if we use a real gas, a determination of certain physical constants of the gas and the use of the laws of thermodynamics enable us to calculate the difference between the apparent temperature indicated by the expansion of the gas and the true thermodynamic temperature.

The International Committee on Weights and Measures adopted as the standard thermometer scale that defined by the constant-volume hydrogen thermometer. Since hydrogen approaches closely the condition of a perfect gas, the difference between this scale and the thermodynamic scale is very small.

Following upon a description of Thermoelectric and Resistance pyrometers, the author proceeds with a discussion of the principles involved in Optical and Radiation pyrometers.

The intensities of the radiations of various wave lengths emitted depend not only upon the temperature but also upon the material that emits the radiation. But fortunately there are certain conditions that give a kind of radiation which depends upon the temperature only. If a closed vessel of any solid material is heated to a uniform temperature the nature of the radiation inside the vessel depends only upon the temperature and not upon the material. Such a vessel is commonly called a "black body." If a hole is made in the wall of the vessel that is small relative to the dimensions of the vessel, the radiation within the vessel is changed only a little, and the radiation that comes out of the hole is very nearly "black body radiation." This radiation is of all wave lengths, both visible and invisible. The influence of temperature upon its composition is known, and is expressed by the following equations :—

$$E = \sigma T^4 \qquad \text{Stefan and Boltzmann}$$

$$I = \frac{C_1}{\lambda^5 \left(\frac{C_2}{e\lambda T} - 1 \right)} \qquad \text{Planck}$$

$$I = \frac{C_1}{\lambda^5 e^{\frac{C_2}{\lambda T}}} \qquad \text{Wien}$$

E = total energy radiated from unit area in unit time.
λ = wave length.
I = energy per unit range of wave length radiated from unit area in unit time.
T = absolute thermodynamic temperature.
e = base of Napierian logarithms.
σ, C_1, C_2 = universal constants.

When the wave length is expressed in centimetres, and the area in square centimetres, and the gram calorie, second and centigrade degree are used, the values of these constants are :—

$$\sigma = 1.28 \times 10^{-12}$$
$$C_1 = 8.8 \times 10^{-13}$$
$$C_2 = 1.445$$

The Stefan-Boltzmann law is strictly correct. It was obtained experimentally by Stefan and was later proved on the basis of the thermodynamics by Boltzmann.

The Planck law agrees with observation, and Planck and others have presented theoretical demonstrations. These demonstrations have not been founded upon such unquestionable principles as those underlying the

* Presented at a meeting of the Section of Physics and Chemistry held Tuesday, February 14, 1918.

Stefan-Boltzmann law, and have given rise to much discussion among physicists; but the weight of observational and theoretical evidence is such that the relation may be safely employed.

The Wien law, which was published before the Planck law, is not strictly correct; but its errors are large only for long wave lengths in the infra-red radiation, while for visible light the difference between this law and Planck's is below the limits of observation. It is, therefore, employed in optical pyrometry, and leads to much simpler calculations than the Planck law.

Each of these laws give the radiation from the black body. There is also radiation from the surroundings or from the observing instrument to the black body, and the net transfer of energy is the difference between the two; but in pyrometry the latter effect is negligible.

There are two important classes of pyrometers employed at very high temperatures; those that depend upon the intensity of visible light, called optical pyrometers, and those that depend upon the total radiant energy of all wave lengths, commonly called radiation pyrometers.

Both optical and radiation pyrometers are usually calibrated to read correctly when sighted upon a black body. The interior of a furnace fairly uniformly heated usually approximates black body conditions, but it is often required to measure the temperature of objects in the open, for example, red-hot billets of metal in the process of rolling. In such cases it is necessary to know the emissivity of the particular material observed, that is, the ratio of the intensity of the radiation it emits to that emitted by a black body, or to calibrate the pyrometer by comparing observations made with it with the temperature of the material as measured in some other away, as by thermocouples. The emissivity is a function of both temperature and wave lengths.

Temperature Table.

Some of the more important or more interesting high temperatures are shown in the table. The very high temperatures, except those of the stars, have been measured with optical or radiation pyrometers. The determination of the surface temperature of the sun is based upon the assumption that it radiates like a black body. The estimates of the surface temperatures of the stars have been based upon observations of the distribution of energy in their spectra. These estimates are quite uncertain. The temperatures in bold-face type are accurately known and are employed as fixed points in the calibration of pyrometers.

	Centigrade Degrees.
Stars (at surface) .....up to about	20,000
Sun (at surface)	6,000
Highest temperature yet produced artificially	6,000
Carbon arc	3,800
Tungsten melts	3,400
Magnesia melts	2,800
Lime melts	2,570
Iron boils	2,450
Copper boils	2,300
Alumina melts	2,050
Platinum melts	1,755
Fireclay melts ..... 1,560 to	1,725
Palladium melts	1,550
Pure iron melts	1,530
Nickel melts	1,452
Cast iron melts ..... 1,100 to	1,250
Copper melts	**1,083**
Gold melts	**1,063**
Silver melts	**961**
Antimony melts	**630**
Sulphur boils	**444.6**
Zinc melts	**419**
Tin melts	**232**

Refractory Materials.

Carbon.—Carbon exists in the allotropic crystalline forms of graphite and diamond, and in the amorphous state. Diamond and amorphous carbon are converted to graphite by the action of very high temperature.

Graphite is the most refractory material known. At the temperature of the carbon arc, about 3,800 deg. C., its vapour pressure becomes equal approximately to that of the atmosphere, and it vaporises without melting. It is very doubtful whether it has ever been melted. At very high temperatures phenomena sometimes take place which give it very much the appearance of having been melted. For instance, if an arc is produced in a space containing no oxygen, the carbon vaporises from the part heated by the arc, and the vapour condenses on adjoining parts, often forming nodular masses, which look very much as though they had been produced by fusion.

Graphite is a very useful refractory material for laboratory purposes and for many industrial purposes, for the reasons that it is very refractory, conducts electricity, and can be easily machined into almost any shape. Several forms of high temperature laboratory furnaces have graphite electric heaters.

Metals.—The most refractory metals are of interest in connection with the manufacture of filament electric lamps. Of these metals tungsten is the most refractory, and is the one now in use in lamps. Tantalum, molybdenum and osmium are also very refractory.

Metals of the platinum group are all refractory, whilst some base metals, especially alloys, containing chromium and nickel, are used for electric heaters at moderate temperatures. A temperature of 1,100 deg. C. is about the limit for such heaters.

Oxides.—Many metallic oxides are highly refractory. Magnesia, one of the most refractory, has a melting point of 2,800 deg. C., while that of zirconia is possibly higher.

Lime, with a melting point of 2,570 deg. C., is very refractory, and has some advantage in mechanical properties over magnesia.

Thoria and ceria are used in Welsbach gas mantles. Beryllia is very refractory, but has received little application.

Alumina, melting at 2,050 deg. C., forms the basis of the abrasive known as "alundum," which is made by fusing alumina and grinding the compact mass thus obtained.

Silica is used commercially as brick, and also forms a valuable glass. It melts at 1,710 deg. C., forming so viscous a liquid that very little crystallisation occurs on cooling, and the product is a glass of very low expansion co-efficient, which makes it capable of resisting sudden changes of temperature. Since this is made by fusing quartz, the most common crystalline form of silica, it is often called "quartz glass," though this is not correct, for after fusion it is no longer quartz.

Refractory Brick.—The most commonly employed refractory brick is that made of fire clay. The essential ingredient of clay is the compound $Al_2O_3,2SiO_2,2H_2O$. When this occurs in the pure condition it is known as kaolin. When kaolin is heated to a high temperature the resulting material is a mixture of Al_2O_3,SiO_2 and SiO_2, and has an apparent softening point of 1,740 deg. C. This is, therefore, the highest softening point obtainable in brick containing nothing more refractory than clay. Some commercial fire-clay brick approaches within a few degrees of this value.

If the material used contains in addition to clay the mineral bauxite, $Al_2O(OH)_4$, the material produced under the action of heat has an increased proportion of Al_2O_3,SiO_2, which has a melting point of 1,810 deg. C., and the brick may be more refractory than the best clay.

Production of Artificial Abrasives.

Mr. C. J. Brockbank (Thorold, Ontario) read a Paper on "The Production of Artificial Abrasives in the Electric Furnace" at a meeting of the Birmingham and Midland Section of the Society of Chemical Industry held on Thursday, November 13, at the University of Birmingham. Members of the Birmingham Metallurgical Society also attended. Mr. L. P. Wilson (chairman) presided.

Artificial abrasives require for their production, said Mr. Brockbank, large quantities of electrical energy, such as can be furnished cheaply by the enormous water-power developments of Canada, the United States, and similar countries abroad. Due to this natural advantage there have developed in Canada several plants of large size devoted entirely to the manufacture of artificial grinding materials called by various trade names, but consisting of two groups, one silicon carbide, and the other aluminous abrasive, or artificial corundum. The refractory by-products produced are also of great importance, and have contributed very materially to increased efficiency in the operation of many types of furnaces. The first artificial abrasive was discovered by Dr. Acheson, in 1890, while endeavouring to crystallise carbon by dissolving in melted silicate of alumina fused by a small electric arc in an iron pot. His ignorance of chemistry led to one of the most remarkable discoveries in the electro metallurgical field, and formed the foundation of what is to-day one of the most important industries in the world. Dr. Acheson, conceiving that the blue crystals resulting from his experiments must be a combination of carbon and alumina, and ignorant of their real chemical composition, named the material carborundum.

Silicon carbide is not a universal abrasive, in that it cannot be used on all classes of grinding. It is suitable and highly efficient in the grinding of brittle materials such as cast iron, marble, mother-of-pearl, etc., and the finishing of leather. The physical properties of silicon carbide render it unsuitable for producing the fine, smooth finish required in steel grinding. It is intensely hard (the next hardest material to the diamond), and very brittle. During grinding the edges of the individual grains are constantly fracturing, exposing fresh cutting edges, which score deeply into a tough material such as steel. The discovery that aluminous ores such as bauxite and emery could be electrically smelted with coke, and commercially pure, crystallised artificial corundum obtained therefrom, completed the requirements of the abrasive field, and rapidly forced natural emery into the background, except for a few restricted operations such as glass polishing.

Silicon carbide is formed by the reaction at high temperatures of silicon and carbon. In practice it is found necessary to add varying amounts of sawdust and sodium chloride; the former is to maintain porosity, so that the large volumes of carbon monoxide may escape without causing blowholes at local spots in the furnace; the salt is used to assist in the elimination of the impurities present in the coke and sand as chloride. A typical furnace mixture when all new materials are used is: Petroleum coke, 1,500 lbs.; white sand, 2,520 lbs.; sawdust, 300 lbs. (180 c.f.); and salt, 40 lbs. A considerable proportion of the mixture used in a furnace is not converted into silicon carbide, acting merely as a heat-insulating blanket, and this material will ordinarily be returned to the mixing department. Petroleum coke is the carbon residue left in the stills when distilling crude oils. It is the only form of carbon that can be used satisfactorily for producing the highest grade of silicon carbide. This does not appear to be due altogether to its purity, since good silicon carbide cannot be made from lamp-black, but is in some way due to the readiness with which this form of carbon is converted into graphite by the agency of heat. Charcoal is readily changed to graphite, and similarly will make excellent silicon carbide.

Regarding the finishing of the silicon carbide, Mr. Brockbank explained that the crystalline silicon carbide after removal from the furnace is crushed in a pan mill and treated successively with a sulphuric-acid and caustic-soda bath. This removes the surface impurities from the grain, consisting of graphite, silicon, silicides of iron, and silicide of aluminium. It is then washed and dried in a rotary dryer, and passed over screens which separate the grains into various sizes from ¼-in mesh to $\frac{1}{250}$ in.; finer sizes are graded by hydrostatic methods. This material forms the pure product used by the wheel manufacturer for making abrasive wheels.

Regarding aluminous abrasives or artificial corundum, these are manufactured by smelting a mixture of bauxite and coke in an arc furnace; the impurities, mainly silica and iron oxide, are reduced and settle to the bottom of the furnace, and the fused alumina is recovered in the form of a large pig or ingot weighing four to five tons. A typical furnace mixture is calcined bauxite 1,750 lbs., coke 100 lbs., iron borings 350 lbs.

Manufacture of Silica.

In an article in the "Canadian Machinery" the analysis, density, porosity, and temperature and other information is given, relating to the silica products used in Martin and similar furnaces. The manufacture of these silica products is carried out with compact siliceous rocks, suitably ground, with about 2 per cent. of slaked lime added and sometimes a little clay or ground bauxite. The material is moulded in sharp angle moulds and then dried and brought to as high a temperature as possible in the kiln. Commercial silica products are of three types, those which contain large, medium, or small grains respectively. These grains are surrounded by finely-ground lime and silica.

The analysis of silica products may be quantitative, or by estimation in the state of sulphates of the elements other than silica. The latter method is imperfect, as the lime, alumina, etc., are treated together, and the alumina content ought to be known, because an excess of this results in a lowering of the softening and fusion points. Physical tests are carried out on the commercial products received, on the same products at 1,710 deg. C. for an hour or two, or at 1,650 deg. for long enough for complete expansion.

In density tests apparent and absolute density are measured. The density of qartzites and flint varies from 2.60 to 2.62, or, after high temperature burning, 2.22. If this absolute density is 2.45 to 2.50 it is certain that the burning has not been high enough or long enough, if density is from 2.40 to 2.38, burning can be considered satisfactory. Silica products based on compact flint present small absolute density, which should approach 2.25 to 2.22.

Porosity is determined by the weight of water absorbed by the dry product after 24 hours in water, depending on nature of rock, size of grains, and cement composition, and varies from 8 to 20 per cent. The porosity should increase at 1,710 deg. C. Resistance to crushing is of great importance, owing to great stresses set up by expansion of the products under the high furnace temperatures. High porosity reduces resistance to crushing. The figures vary according to the other physical properties, from 120 to 500 kg. per sq. cm. Whole bricks are heated to 1.710 deg. in a recuperating furnace, and expansion, density, porosity and resistance cold and at 1,500 deg. are determined. Inferior material will be softened, melted or deformed.

The qualities required of silica products are refractoriness as high as possible and above 1,710 deg., smallest possible volume increase, highest possible crushing resistance at high and ordinary temperatures, small porosity and correct grinding and burning. Grinding is done in vertical mills followed by sifting to eliminate over-large grains, which are re-ground. The vertical

mills destroy the edges and no differentiation can be made between the various finenesses of the product. The author considers that in the future the practice of the abrasives industry will have to be followed, viz., crushing, grinding in cylinders, and sifting, which allows classification and separation of fine dust, thus giving grains with sharp edges and of definite proportions.

Burning should take place at the highest possible temperatures, about 1,600 deg. Repeated trials at 1,500 to 1,550 deg. in a tunnel kiln showed that good burning was obtained in from four to five days according to the tonnage to be produced. Good quality silica bricks must be 94 to 95 per cent. silica, but it has been proved that 85 per cent. silica bricks are equally refractory and are far superior as regards crushing resistance at all temperatures. An excess of lime or iron oxide is detrimental.

Design of Electric Furnaces.

R. C. Gosrow, writing in a recent issue of the "Chemical and Metallurgical Engineering," states that observations of a number of electric furnaces varying considerably in size and transformer capacity, and all working under the same conditions, had led the writer of the earlier article to the conclusion that the small furnace is much more efficient in operation than the large furnace. With this conclusion the author does not agree; his contention being that it is not size in the sense of cubic capacity, but the relations of length, breadth, and depth one to another. Also for depth he would substitute "height of ore column." In other words, efficiency is the outcome of proper proportioning rather than size. Resting his case on this basis, and citing his own experience for confirmation, he shows not only that large furnaces may be as efficient as small furnaces, but, in many cases, large units are preferable.

The proper spacing of the electrodes directly affects efficiency in any size of furnace. A necessity of good working is a cool top and a hot hearth. Also the electrodes should be spaced to give as much room for charge as possible. Depth of ore column and length of electrode to carry are, especially the former, factors of great importance. The depth of ore column must bear a definite relation to the material being smelted, and to the metal produced. In smelting chrome and manganese ores, lower ore columns are used than in smelting iron ores. In the electric smelting furnace, reducing gases are not utilised for ore reduction in the descending column; long ore columns, therefore, are not necessary. Also the mechanical strength of carbon and graphitised electrodes must be taken into account. The depth of ore column cannot always be determined by metallurgical conditions. Another important matter in furnace design is the proper proportioning of the distance from the front and back walls to the electrodes. The author's experience has shown that a furnace inner-wall-line should be just close enough to the electrodes to allow the charge to fuse on its surface, while being far enough away to prevent fluxing or melting of the wall refractory. The bad consequences of having the walls too far away are well known.

In considering the question of coke and charcoal in deep and in shallow furnaces, the author gives an example of two different furnaces running on ferro-manganese with the same bus-bar voltages, the same ore, and reducing material, but with different heights of ore columns and different spacing between electrodes. The deeper furnace—9 ft. depth of ore column, 60 in. spacing of electrodes—worked better on coarse coke. The other furnace—7 ft. depth of ore column. 40-in. electrode spacing—worked better on coarse charcoal. The shallow furnace worked well on 1-in. coke, while the other and deeper could not be run at all on 1-in. coke. The author compares some methods of charging, and describes relative metal recoveries from different ores.

Elimination of Strains in Castings.*

By C. J. Wiltshire.

It is a well known fact that appreciable strains which are caused by unequal radiation of heat from the castings after they are poured remain in iron castings after cooling. This unequal radiation is due to variation of section and difference in length of paths through which the heat must pass to escape from inner to outer surfaces. In consequence the heat is not uniformly dissipated. The portions where the metal is thickest and also those most remote from the point of heat exit, retain their temperature longest, and as result, shrinkage strains are set up in the parts which cooled first.

Some 22 years ago, Alexander Outerbridge, of Philadelphia, discovered that vibration of a cast iron bar (by tumbling in a barrel or by a continued tapping with a hammer) would invariably increase the strength of the casting. The theory of this treatment is that the action of cooling causes molecules of iron to be held in tension which is relieved when the casting is subjected to vibration.

It has since been found that this tension can be relieved by annealing the castings in an oven of moderate temperature. It is the purpose of this paper to describe the method.

That shrinkage strains exist in most castings is demonstrated by the fact that if a plain cast-iron plate be machined to a true surface on one side, the operation of machining the other side will frequently disturb the accuracy of the surface first finished.†

Large castings which have been left in the sand to cool off slowly and then finished to true dimension, have been found distorted under ordinary temperature changes, after a few days, but these same castings after treatment in the oven did not show any change whatever.

Other castings which have been finished and put under steam for test have shown considerable distortion when taken apart, while castings from same patterns when treated in an oven before finishing and tested out in the same way, showed no change.

Again, large castings which have been finished and lined up as part of a large unit, have shown sufficient distortion to cause parts of the machine to become out of line after a number of months in service. Such castings are now being annealed and from results obtained it is believed that this treatment will prevent the defects experienced.

The method of treatment is as follows:—

The castings are placed in the oven, the doors are closed, the heat turned on, and the temperature raised to 370 deg. C., which generally takes from seven to eight hours. This temperature is held for an additional seven hours, when the heat is shut off and oven is allowed to cool down slowly for approximately 20 hours, with a resulting temperature of about 150 deg. C. The oven doors are then opened and temperature is allowed to drop to approximately 70 deg. C., when the castings are in shape to be taken out. The entire operation consumes about 48 hours.

The ovens are heated with oil, and the amount of oil per ton of castings treated has averaged 9.6 gallons. Each heat required 284 gallons of oil and approximately 29 tons of castings were treated each heat.

THE Simplex Construction Company, Limited, which has a capital of £220,000 in 200,000 ordinary shares of £1 each and 200,000 deferred shares of 2s. each, will shortly make an offer of 175,000 ordinary shares of £1 each, at par.

* A paper presented at the Philadelphia meeting of the American Foundrymen's Association.

† L.M. Sherwin, Proc. A.F.A., 1917,

A Contribution to the Study of Ferro-Silicon.

By M. A Sanfourche.*

The equilibrium diagram of the iron-silicon alloys has already been constructed by Messrs. Guertler and Tamman. A small number of alloys only were used in this work, and the author has re-investigated the series, using a larger number of alloys.

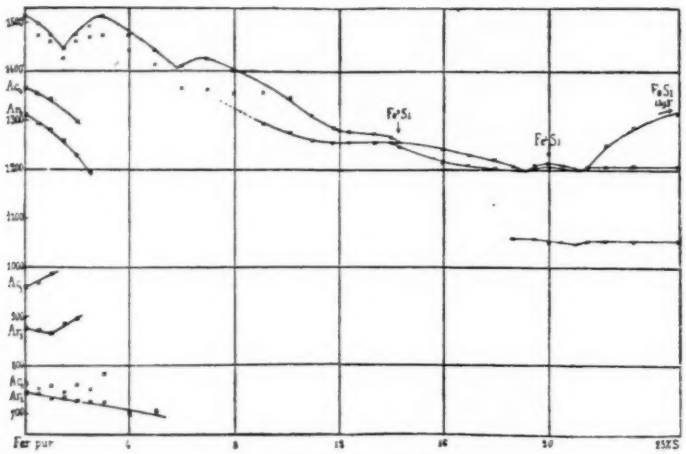


FIG. 1.—FUSION DIAGRAM.

A detailed description of his results is given in the following text :—

Fusion Diagram.

The fusion point of the pure iron was found to be 1515 deg. C., which is rapidly lowered by the addition of silicon till in the alloy containing 1.5 per cent. silicon, the end of the liquefaction is 1445 deg. C. From this point the temperature increases almost immediately, till in the sample containing 3 per cent silicon it is 1516 deg. C., which is a little higher than that of the original pure iron. From this point the temperature again decreases till in the alloy containing 6 per cent. silicon it is reduced to 1410 deg. C. The preceding phenomena again present themselves, although to a less degree. The fusion point of the 7 per cent. sample is again increased to 1427 deg. C., after which the temperature regularly decreases until the 14.30 per cent. silicon is reached where fusion is complete at 1256 deg. C.

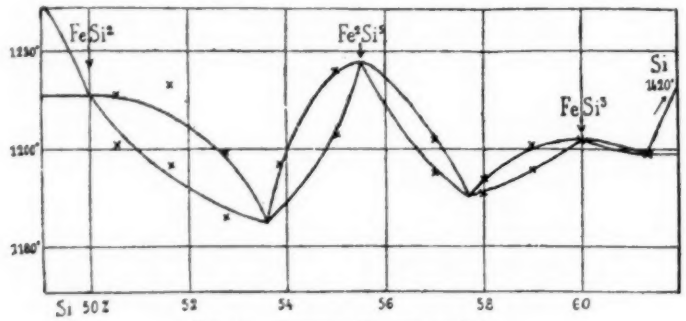


FIG. 2.—CRITICAL POINTS OF IRON.

The two maxima occurring at 3 per cent. and 7 per cent. silicon respectively, in all probability do not correspond to definite chemical compounds. If this were the case, their fusion as a univariant system would necessarily take place at a constant temperature; but this is not the case, and, as a matter of fact, the solidification interval in these particular alloys is actually greater than that of the neighbouring alloys.

It is extremely difficult to trace the course of the solidus curve in these alloys, and it is also difficult to give a rational explanation of the form of the liquidus curve from 0 to 8 per cent. of silicon. It would perhaps be possible to explain the case by analogy with the alloys of iron and chromium, which also present two maxima not corresponding to definite chemcal compounds. Mr. Portevin calls such systems *pseudo-binary* and assumes that the compound or

* Revue de Metallurgie, No. 3, May June, 1919.

solution might then be partially dissociated, thus in effect transforming the binary system into a ternary system. This singularity would appear to be up to the present confined to certain alloys of iron. It is possible that this is in a measure due to the lack of precision in taking the diagrams.

The solidus becomes horizontal a little after 11 per cent., and then meets the liquidus at 14.30 per cent. silicon at a temperature of 1256 deg. C. This point is possibly the termination of the first series of solid solutions. (The compound Fe_3 Si, should it exist, requires 14.29 per cent. Si.)

A little before this point, at a concentration of 14 per cent. silicon, a new series commences, as well defined as the latter, and which end with a silicon content of 19 per cent., and at a temperature of 1199 deg. C. This is followed by another series from 19 to 21.5 per cent. silicon, the alloy of the concentration 20 per cent. silicon corresponding to the definite compound Fe_2 Si. The existence of this compound would appear to be definitely established as a result of the work of other investigators. It is important, however, to note that the fusion of this alloy does not take place at an invariable temperature, but over an interval of 4 deg. C. (from 1207 deg. C. to 1211 deg. C.).

This solid solution (or compound) is the only one which shows a transformation apart from the ordinary critical points of iron. The transformation does not commence exactly with the series of solid solutions which it affects; but a little before, as it is already sensible in the alloy containing 18.65 per cent. silicon at a temperature of 1058 deg. C.

The existence of the compound Fe Si is also confirmed.

The Critical Points of Iron.—The position of the transformation points of iron is generally influenced by the presence of Si. The author indicates a new point, which is designated A_{1a}, and which corresponds to the point observed by Curie. It occurs on the pure iron curves as a very small retardation at 1310 deg. C. on cooling, and 1365 deg. on heating. The addition of silicon up to 1 per cent. does not vary its intensity, but lowers the temperature. With increasing silicon it becomes less in magnitude, and disappears about 2.5 per cent. Si. The following table indicates the exact position of the A_1 transformation :—

TABLE I.

Silicon content per cent.	Ac_1	Ar_1
Pure Iron	1,365 deg. Cent.	1,310 deg. Cent.
0.5	1,355 ,, ,,	1,294 ,, ,,
1.0	1,342 ,, ,,	1,281 ,, ,,
1.5	,, ,, ,,	1,259 ,, ,,
2.0	1,297 ,, ,,	1,225 ,, ,,
2.5	,, ,, ,,	1,195 ,, ,,

The variation in the A_3 point is given in Table 2, from which it will be seen that an increase in silicon

TABLE II.

Silicon content per cent.	Ac_3	Ar_3
Pure Iron	959 deg. Cent.	877 deg. Cent.
0.5	969 ,, ,,	872 ,, ,,
1.0	989 ,, ,,	867 ,, ,,
1.5	,, ,, ,,	887 ,, ,,
2.0	,, ,, ,,	893 ,, ,,

gradually raises the temperature of this point; exactly the opposite behaviour to that of carbon.

The variation of the Ac_3 point are also given in Table 3.

TABLE III.

Silicon content. per cent.	Ac_3	Ar_3
Pure Iron	765 deg. Cent.	746 deg. Cent.
0.5	754 ,, ,,	744 ,, ,,
1.0	760 ,, ,,	731 ,, ,,
1.5	786 ,, ,,	740 ,, ,,
2.0	761 ,, ,,	727 ,, ,,
2.5	750 ,, ,,	725 ,, ,,
3.0	783 ,, ,,	723 ,, ,,
4.0	697 ,, ,,	696 ,, ,,
5.0	705 ,, ,,	700 ,, ,,

The author states that the instruments used in the research were not sufficiently sensitive to detect the A_2 transformation in the alloys exceeding 5 per cent. silicon. The same remarks also apply to the determination of the A_3 and A_4 transformations.

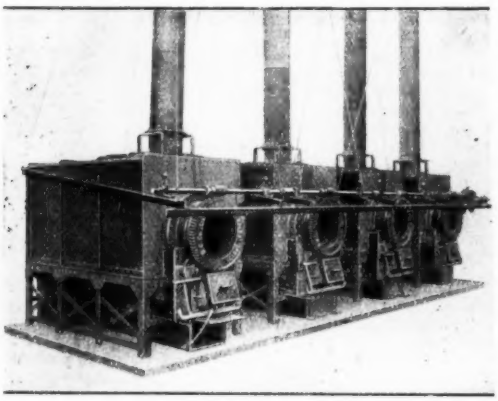
We have received from Messrs. Hall & Pickles, Limited, 64, Port Street, Manchester, an advance copy of a booklet descriptive of their "Hydra" brands of tool steels. Particulars are given in tabular form of the various shapes and sizes of bars, their length, weight in pounds per lineal foot, and corresponding code word in each case. Considerable space is devoted to the treatment of the various brands of steel, together with a useful temperature chart, showing in colours the degrees of hardness suitable for different classes of work. A number of tables and several photographs complete the work.

THE PLATINUM SITUATION.—Mr. J. M. Hill, U.S. Geological Survey, states in a recent issue of the "Engineering and Mining Journal" that as all commercial platinum is not pure metal, much use is being made of iridium alloys. For electrical purposes platinum contains about 15 per cent to 50 per cent. (average 25 per cent.) of iridium, and for jewellery purposes 5 per cent. to 10 per cent. Platinum may be replaced by palladium gold alloys for jewellery and dental work, rhodium is used for electrical pyrometers, and there are minor applications of osmium and ruthenium. Pure platinum is, however, required for the chemical industry for catalysers, in the manufacture of sulphuric acid and for the manufacture of nitric acid from ammonia. Asbestos or anhydrous magnesium sulphate, soaked in platinum chloride and subsequently baked to drive off the chlorine, forms the contact mass for contact acid plants, and fine platinum gauze is used for the catalyser in nitric acid plants. Platinum crucibles, dishes, tongs, triangles and wire are required in every chemical laboratory. Tungsten, molybdenum, and nickel-chrome alloys are being tried as substitutes for platinum for electrical purposes, but they have not yet supplanted the latter metal. The non-essential use of the platinum metals in jewellery should be stopped. At present Russian platinum mines are almost idle. The dredges are mostly not operating, and the industry disorganised. It will take months or years to get in full swing again, and the known deposits there are becoming exhausted. Columbia appears to have large reserves, and the Alaskan resources appear to be increasing. It is considered that the present price of $105 per oz. is several times the value of the metal, but that the price will remain nearer $75 than $50 per oz. for several years to come.

Case-Hardening in Rotary Furnaces.

On a recent visit to important engineering works in the Midlands, our representative had an opportunity of seeing rotary furnaces in operation which have enabled the company concerned to effect striking economies in the costs of case-hardening certain parts, more particularly in regard to work of repetition order. Prior to the adoption of the rotary furnace all case-hardening was done in boxes, as is the common practice, and the furnaces under notice do not supersede, but merely supplement the older process, as obviously the rotary furnace has its limitations, and its use must perforce be confined to dealing with parts which are not liable to be injured by the rolling contact.

The five furnaces, supplied by the British Carbonizing Company, Limited, Vulcan Works, Gloucester, are installed as independent units. From many points of view this is perhaps the most convenient arrangement, especially when, as in the



Battery of Four Rotary Furnaces coupled up for One Drive.

case in point, they are coke-fired, though the design of the furnace lends itself very readily to battery installation, which would be the most economical arrangement for a number of furnaces where producer gas is employed as the fuel. In such an arrangement, however, provision would be made for shutting off any one of the battery of furnaces, so as not to interfere with the remaining furnaces in the battery when it becomes necessary to renew a retort; as at the works at Gloucester, where four furnaces are coupled up to one main drive.

The body of the furnace is merely a substantial steel casing firebrick-lined, provided with bearing rollers at either end. Upon these rollers rotates a cylindrical cast-iron retort which is permanently closed at the rear—the firing end of the furnace—whilst the front end is closed after the retort is charged, by a plate which is sprung from the door; in each case the ends of the retort are closed well within the hot zone, so that the working portion of the retort or muffle is uniformly heated throughout its length. To the rear end of the muffle is bolted a gear ring into which meshes a worm driven by worm gearing from a belt-driven shaft, thus causing the retort to slowly revolve on its supporting rollers.

The method of operation is to charge the furnace with the parts for case-hardening together with from 10 per cent. to 12½ per cent., by weight of a special composition, and then effectively to seal the entrance. As previously stated, special provision is made for this, which is most important, inasmuch as the action of the composition is a gaseous one, the composition employed giving off at the correct temperature a profuse CO gas from which the carbon is assimilated. It will be obvious that, unlike the box process, the action cannot be wholly a contact one, but is in part contact and gaseous and at the same time under a pressure of many lbs. to the square inch, so that its action is thoroughly uniform, as the process ensures that each piece of the charge receives the same degree of heat, and, consequently, each piece of the charge will absorb the same quantity of carbon, a condition which is very difficult if indeed not wholly impossible when the charges are packed in boxes. Further, as the pyrometer can be introduced into the heart of the retort, accurate records of the temperatures can be obtained.

The comparison of the floor space required for furnaces working on the old and new systems is very striking. Coal-fired furnaces with seven carburizing chambers occupied a floor space of 80 ft. × 30 ft. = 2,400 sq. ft.; total output of 48 cwts. of carburized work in 24 hours. Three rotary furnaces occupy a floor space of 32 ft. × 20 ft. = 640 sq. ft., and with only three men operating give an output of 63 cwts. in the same time. In the matter of working costs, the figures are still more remarkable, being 18s. 5¼d. and 3s. 10½d. per cwt. for the coal-fired and rotary furnaces respectively; these figures are inclusive of all labour charges, material, boxes, renewals, and in the case of the rotary furnace renewal of retorts, but do not include furnace maintenance or interest on capital outlay.

The life of the cast-iron retort is approximately 14 days, and when a renewal is necessary the furnace has to be stood off for a night to cool down, and a day is taken by two men to fit in the new retort. We understand, however, that later arrangements considerably curtail the time taken in this respect.

When the present stock of retorts is exhausted the Company will use retorts made of steel instead of cast iron; trials have already been made with these last, and their length of useful life has proved to be at least 60 days, so that whilst their cost at the present time is four or five times more than the price of the cast-iron retorts, it will be seen that upon their length of life alone they are the better investment, without taking into consideration the loss of output whilst the furnace is shut down, labour charges for renewal, and expenditure on fuel for heating up after the renewal has been made.

We are informed that arrangements have been made with the Richmond Gas Stove and Meter Company Limited, London and Warrington, to build and equip these furnaces, evidence at once that the construction and workmanship will be all that can be desired.

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Forthcoming Events.

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Manchester Association of Engineers:—"Cast-iron in Theory and Practice," by E. Adamson.

JANUARY 16.

Wolverhampton and District Engineering Society:—"Extraction Turbines," by C. H. Naylor.

NOTES AND COMMENTS.

The Foundry Industry.

In our December issue various questions relating to the future of the ironfounding industry were dealt with in the presidential addresses given before the respective Branches of the Institution of British Foundrymen. In particular we commend to the careful consideration of all those interested in the future development of ironfounding the address before the Sheffield Branch of the Institute by Dr. W. H. Hatfield.

It has now become quite customary in considering the ironfounding industry of the country as a whole to draw comparisons between our own practice, both technical and commercial, and that of the industry in America. Dr. Hatfield, in his address, has not departed from this custom, and he draws attention to an aspect of American foundry practice which is apt to be overlooked by a large number of foundrymen in this country. This aspect is that of the cosmopolitan nature of the foundry employés. Quoting from his own words he states that "over there instead of having a foundry full of workpeople all of British origin, you find it filled with all the races of Europe and, I might add, Africa." This is a great regrettable but incurable fact. You have Russians, Poles, Hungarians, Italians, and negroes all working side by side, most of whom have gone to America with one object, namely, to make as much money as they can and to put all their energy into their work, so as to make themselves financially comfortable in as short a time as possible. This means that the executive organisations of American works have their shops full of people who are putting all in, *i.e.*, doing as much work as they possibly can, and obviously convinced by experience that they do so without the danger of their concerns not being able adequately to dispose of their products.

That reveals a different condition of things from those exising in this country, where for many years there has been a great tendency to reduce output.

Dr. Hatfield also points out that "standardisation"—the underlying principle of all "mass production" schemes has been carried out more fully in America than in this country. We believe it is now well known in this country that mass production is one of the most favourable means whereby the cost of production of any article can be lessened. To what extent this and its underlying principle of standardisation is realised by each and every member of the ironfounding industry—employé and employer alike is—another matter. We repeat, therefore, that more intensive efforts are still required to bring about further standardisation of cast-iron parts to enable the more extended and the adoption of quicker and more efficient means of manufacture, which in their turn will lessen the production costs and enable the British foundries to more successfully compete in the open markets.

Proceedings of the Institution of British Foundrymen.

The printed volume of the proceedings of the British Foundrymen's Association, now "The Institution of British Foundrymen," is now to hand. This volume contains the report of the fifteenth annual conference, held in Sheffield in June, 1918, and also the papers and presidential addresses given at the Branch meetings held during the Session 1917-1918.

The whole of these papers included in this volume were given before the Branches in the midst of the stress of the Great War, when all the foundry trades, and the persons connected therewith, were fully occupied in maintaining the country's supply of munitions. These factors taken into consideration, it must be allowed that this volume of papers is an index of the enthusiasm, energy and interest on the part of the whole organisation and members of the Institution of British Foundrymen.

Foreign Foundry Practice.*

By A. O. Backert.

Several months ago the writer returned from an extended visit to England and France where he was afforded unusual opportunities to study conditions prevailing in the foundry and iron and steel industries. The people of both countries then were still suffering from the tremendous shock of the war and the readjustment of their industrial activities to a normal status was beset with many difficulties and problems that seemed almost insurmountable. Their national debt, which exceeds per capita many times that of the United States and the depreciated value of their money as measured by the dollar standard are causes for great concern among manufacturers and financiers. Otherwise conditions generally are not unlike those confronting us to-day.

In the United Kingdom the demobilisation of the army was speeded up to a higher rate than in France. The return of millions of these men to peace-time pursuits, particularly those who have been out of touch with civil life for from four to five years, involves difficulties that time alone can solve.

It has been the prevailing practice of investigators of industrial conditions abroad to make invidious comparisons of production as compared with that of the United States. From the standpoint of tonnage and per capita output, particularly in the metal trades, these comparisons are borne out by statistics. However, there must be some underlying reasons for the wide divergence in these figures and more than a cursory examination revealed the causes. It has been pointed out frequently that restraint of output is the brake upon all industry of the United Kingdom, and that with its removal production could be speeded up to equal that of this country. Attention also has been directed to the lack of labour-saving equipment and the need of mechanical appliances to increase output.

Difference in Buyers' Standards.

A more than superficial investigation of the foundry industry of the United Kingdom discloses the effect of the restraint of output, which, however, was removed during the closing years of the war and has not again been invoked. Mechanical appliances are not in such widespread use in the casting industry as in this country. Yet many plants are modernly equipped throughout and their practice is equal to the best prevailing in the foundries of the United States. Then what are the underlying causes for the differences in the rates of production? Why is the tonnage per man for shops engaged in similar work so much greater here than in the United Kingdom?

The wide divergence in the standards of the casting buyers of the two countries is one of the underlying reasons. The insistence upon high quality and superfine finish are two requirements that slow-up production abroad. The widespread use of dry sand moulds in the United Kingdom and also in France, to provide the necessary finish demanded by the trade, is a large factor in reducing the per capita output. Quality and finish have been carried to the extreme and at the sacrifice of quantity. In the shops in this country, on the contrary, green sand practice prevails and quantity production is the goal to be attained, frequently at the expense of finish and quality. That a happy medium between the extremes of quality and quantity would serve the purpose cannot be denied, but years of education in one direction cannot be diverted to another course without an equal amount of training.

Repetition work in this country is one of the factors underlying large production, and it lends itself admirably to the application of all kinds of mechanical and labour-saving devices. With us it is not unusual to make 50,000 castings from the same pattern, and in the automobile trade this total frequently is exceeded. Dealing in large numbers of the same unit enables the American foundryman to equip for quantity production and he requisitions for his use the most modern mechanical devices available to increase output and reduce cost. In the United Kingdom and France, repetition work is not nearly so prevalent as in the shops of the United States. Quantity production of commodities is not appreciated in the same degree as over here, nor is the need for it nearly so great. Until this year quantity was not a great factor in the motor car industry abroad, and even to-day the largest output of the automobile plants of both of these countries is dwarfed by the annual production of many of our motor car manufacturers.

Lack of Standardisation.

In addition, the lack of standardisation in many of the engineering lines reduces repetition work to the minimum. Even the railroads are counted among the violators of standards in equipment and the whim of the designer too frequently is the altar upon which quantity production is sacrificed. It has been stated that manufacturers of sanitary ware in the United Kingdom have patterns in their vaults for several thousand different designs of bath-tubs and it is not unusual for an architect to enhance the beauty of his creation by individually designed tubs. Thus, the lack of repetition work may be assigned to a multiplicity of orders for small numbers of castings from different patterns, and this plays havoc with production.

To the comparative lack of repetition work in both the United Kingdom and France must be assigned the prevalence of the jobbing shop and the large number of small foundries, willing, even if not equipped for the production of castings in iron, brass or steel. However, this semi-job work is not without its compensating features. It has a tendency to develop skilled moulders, whereas our specialty shops train men to one operation, not one of whom could make a parting or cut a gate by hand. Notwithstanding these handicaps, the mechanical equipment of many of the United Kingdom and France measure up to the best practice prevailing in this country. And the foundrymen of these countries are alive to the progress that is being made in casting manufacture over here. They are anxious to increase their production and to reduce their costs, and to attain these ends they are preparing to instal labour-saving equipment on an extensive scale.

Steel Casting Manufacture.

Steel casting manufacture in the United Kingdom was greatly accelerated by the war. The output in 1918 totalled 276,518 tons, of which basic steel was only 10,564 tons, as compared with 265,954 tons of acid castings. This tremendous predominance of acid over basic steel, which is in striking contrast to the practice prevailing in this country, must be attributed to a large extent to the insistence of the army and navy ordnance departments for castings made by the acid in preference to the basic process, and also, in a measure, to the available ores. The war also speeded the installation of electric furnaces for the production of steel for castings. At the time of the armistice thirty-seven were in operation in foundries with an actual output of more than 5,000 tons per month, and eleven additional were being installed, which will increase the actual production to 7,000 tons per month.

When the war was terminated, electric steel casting production was at its height in the United Kingdom, as indicated by the output of 46,637 tons in 1918 and compared with 108,296 tons for the United States in the same period. Of the total steel casting output of the United Kingdom in 1918, the electric process accounted for 17 per cent. against 7.7 per cent. for the United States, indicating a production in proportion to the total steel casting output more than twice as great as that of this country.

* Abstract from the presidential address of A. O. Backert, at the opening session of the Interallied Foundrymen's Convention and Exhibition, Philadelphia, Sept. 30.

Statistics of the steel-casting production of the United Kingdom and the United States for 1918 follow :—

	United Kingdom. Tons.		United States. Tons.
Acid open-hearth	103,731	...	634,950
Basic open-hearth	9,899	...	505,880
Converter	116,231	...	160,844
Electric	46,657	...	108,296
Crucible	—	...	1,330
Miscellaneous	—	...	110
Total	276,518	...	1,411,410

Following the curtailment of ordnance buying and the cancellation of existing contracts in November last year, many electric furnaces in steel foundries were shut down and the production this year will show a material decline in the United Kingdom. This is due to the high cost of manufacturing this grade of steel and the comparatively limited demand for electric steel castings for commercial purposes.

The Reduction of Sulphur in "Blackheart" Malleable Cast-Iron.

In a recent Paper read before the American Foundrymen's Association, A. W. Merrick states that the American or blackheart malleable cast-iron produced in the United States is usually melted in air (or reverberatory) open-hearth or cupola furnaces. Either of these types of furnaces offer certain inherent advantages and disadvantanges, but as it is with the last-named that we are to deal in this Paper, the discussion will be limited to this one method of melting.

Its advantages are briefly as follows : Low initial investment; low cost of operation, upkeep, and repairs; intermittent or continuous operation which gives a great flexibility of capacity; high melting ratio of iron to fuel, and ability to melt high percentages of cast-iron and steel scrap without the consequent lowering of the carbon content which would necessarily follow in either of the two types of furnaces.

There are, however, certain disadvantages in cupola melting as applied to cast-iron in general and malleable cast-iron in particular. First, the sulphur absorbed from fuel is higher with this process than either of the others. Secondly, it is not possible to produce an iron of a low carbon content, which with malleable iron limits one to the production of casting of very light section. This is due to the fact that the melting stock, being in intimate contact with the incandescent carbon of the fuel, absorbs carbon so readily, that with the constant silicon aimed for in malleable iron, a practically saturated condition is reached so that with other conditions equal, the carbon is never very far either above or below a fixed point. This holds good even when the percentage of steel in the charge is varied considerably. Thirdly, cupola iron, especially on long heats, is liable to quite a variation in temperature and composition. The latter evil is especially aggravating in malleable work where the importance of keeping the two elements sulphur and manganese, in a proper relationship is well recognised.

In order to overcome these last two disadvantages we might utilise some sort of a mixer that would act as a reservoir and by holding a given quantity of metal allow it to become constant in temperature and composition. The difficulty with this plan, is, of course, that the temperature of the molten metal would be constantly lowering unless some external source of heat were applied, so that the question narrows itself down to just what this source of heat would be. The electric furnace, at once suggests itself as ideal, for in addition to supplying the heat needed, it will also allow the removal of the greater part of the sulphur by use of a proper slag. Not only this, but it will, in addition, allow an iron of any carbon content to be made by the means of additions of either cold or liquid steel, so that compositions of any range of carbon and silicon can be made and any castings of sections practicable in malleable iron may be poured. The advantages of such a duplex process are readily apparent to anyone familiar with the production of cupola malleable iron. Cupola iron is especially suitable for castings of light section, such as pipe fittings, etc. In the latter case where an iron high in carbon is desirable, because of the greater ease of threading the fittings this process should recommend itself immediately. In addition to the advantages previously enumerated it would permit the annealing of the white iron at a considerably lower temperature than is practicable with a high sulphur iron, such as is ordinarily produced in the cupola.

Experiments are then described showing the extent of sulphur reduction possible by this process. It is suggested that the formation of calcium carbide in the refining slag is instrumental in the reduction of the sulphur.

Among the conclusions which the author arrived at are the following :—

1.—The cupola is the cheapest method for producing molten cast-iron, but the process has several inherent disadvantages that have limited the use of cupola malleable to work of light sections. It produces iron high in sulphur, and variable temperature and composition.

2.—The electric furnace is capable of refining this iron, reducing the sulphur to a negligible amount and super-heating the metal to any desired degree without any further altering of composition.

3.—Such a process as described will permit iron of any carbon and silicon desired to be made by the proper additions of steel and ferrosilicon.

4.—Where this duplex process is used, the amount of scrap used in the cupola can be increased and the fuel decreased as it would not be necessary to have the iron as hot as is the practice when poured direct into the moulds.

5.—The mixtures would have to be kept low in manganese, no high manganese pig or spiegeleisen would be used, and it is believed that by using low manganese scrap that the amount of manganese burned out in the cupola would lower this element to the point desired. This will have to be worked out definitely in the future from further experimental data.

6.—As to costs, no figures can be given as the process is not believed to be in operation as specifically outlined in this Paper. However, the power required ought not to be more than 150 to 200 kilowatt hours per ton on molten metal from the cupola, and with continuous operation, the labour charges should not be excessive. These costs would be offset by the lower cost of melting stock reduced amount of coke used in melting and the lower temperature of the annealing ovens for the annealing of such low sulphur iron.

A NEW FERRO-ALLOY.—The "Iron Trade Review" states that the Shawinigan Electro-Products Company, Baltimore, has produced a new ferro-alloy containing silicon and aluminium. Analysis of the new alloy shows : Silicon 47.70, aluminium 43.63, and iron 218.67 (total 120!). The process of manufacture, which is by the electric furnace, allows the relative proportions of silicon and aluminium to be varied to any desirable extent, as long as the silicon content remains near 50 per cent. This alloy is intended for use in steel making as a deoxidising agent. The combination is said to provide silicon and aluminium at a lower price than they can be obtained separately. A number of steel makers are now experimenting with this alloy.

The Alloys of Copper and Silicon.

By M. A. Sanfourche.

In a recent issue of the "Revue de Metallurgie," the author states that the alloys of the copper-silicon series have been studied by a large number of investigators who have indicated certain definite chemical compounds formed by the two elements.* The more recent work attempts to prove the non-existence of certain of these compounds. In particular the diagram as drawn by Rudolfi does not show any compounds other than Si Cu_3 and Si_4 Cu_{15}. This latter compound is indicated as being formed by reactions occurring in the solid alloys.

The study of the thermal equilibrium of the copper silcon series was undertaken in conjunction with M. Vigouroux, and a provisional solidification diagram has already been described by this latter worker (Rev. de Mett., 1912). Since this time the authors have completed the study and added to the diagram the transformations in the solid state.

The materials used in the investigation were electrolytic copper in the form of thick wire. This was found on analysis to contain 7/100000 parts of iron. Crystallised silicon was used which on treatment with hydro-fluoric acid left 0.52 per cent. of a residue which did not contain iron. The actual alloys, however, contained on an average 0.25 per cent. of iron, which was probably derived from the porcelain tubes in which the alloys were prepared.

Microscopic Examination.—Nearly all the alloys having served for the construction of the diagram were examined under the microscope, after polishing. For the most part they were etched with HNO_3, which acts on all the constituents except the silicon, but to a different degree. A very light polishing after the etch then shows the harder constituents in relief.

Several specimens were examined after treating with concentrated potash solution by boiling for 15 minutes. The action is not very strong. The only advantage of this method is that it hastens the colouring of the constituents, which otherwise take many days' exposure to the atmosphere to take the red, or iridescent, colour necessary for examination by this method.

Equilibrium Diagram.—(1) *From 0 to 8.60 per cent. Silicon.*—The first branch of the liquidus commences at the melting point of copper, 1.084 deg. C., and this ends with a composition of 7.58 per cent. silicon at the transition point A at a temperature of 845 deg. C. From 0 to 4.33 per cent. silicon there are no definite arrest points, but intervals in which the rate of cooling is slower, indicating the deposition of mixed crystals of a variable composition, whose compositions at the moment of solidification are indicated by the solidus portion of the curve Cu-a.

From 4.33 per cent. to 7.58 per cent. Si solid solution crystals are primarily deposited of a composition represented by the point a (4.33 per cent. Si). At the same time the concentration of the mother liquor increases till the point A is reached (7.58 per cent. Si., 845 deg. C.). At this point a reaction takes place between the solid solution a and the liquid A, giving rise to a solid solution b, having 6.80 per cent. silicon.

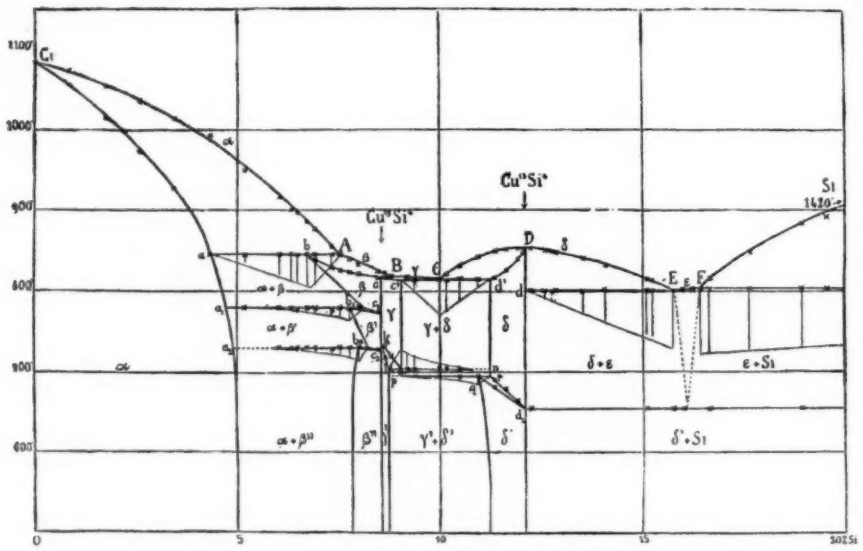


FIG. 1.

The formation of a second series of solid solutions extending from the transition point A to the point B is indicated by the curve β. The point B corresponds to a concentration of 8.80 per cent. silicon at a temperature of 820 deg. C. The concentration of the crystals deposited is indicated by the solidus b c.

The a solid solutions are the only ones in the series which do not exhibit transformations after solidification.

On the contrary, the β mixed crystals undergo two successive transformations as follows :—

(*a*) The β crystals saturated with silicon ('8.50 per cent.) show a transformation point, C_1, at 774 deg. C., marked by a slight retardation in the rate of cooling or heating, but without arrest at this temperature, which varies with the composition of the alloy. The system is bivariant. The transformation indicates the appearance of a new phase, β', of the β crystals. Below 8 per cent. Si., on the contrary, the transformation takes place at a constant temperature of 780 deg.

* See Baradue Muller. Rev. de Metallurgie, 1910.

C., the presence of the α crystals render the system univariant. The intervals are recorded on the line a, b. These are inappreciable up to 6 per cent. Si., but increase regularly, attaining a maximum at 7.80 per cent. Si., after which it decreases till it is absent at 8.20 per cent. Si. This point therefore marks the limit of the existence of α (alpha) mixtures with β.

(b) An analogous transformation, C_2, in which the β_1 crystals become a new form, β_2, at a temperature of 728 deg. C. This occurs on the curves as a retardation, but not on arrest. The temperature is but little influenced by the variations of the composition of β^1, and when the appearance of the α crystals renders the system univariant, the transformation temperature, fixed by a_2, b_2, is at 731 deg. C. The maximum retardation is reached at 8 per cent. Si., as shown in the diagram.

(2) *From 8.60 to 12.10 per cent. Si.*—The point β (8.80 per cent. Si., 820 deg. C.) is the beginning of a new branch of the liquidus, ending in the point C as eutectic occurring at 815 deg. C. with a concentration of 10 per cent. Si. This branch, B C, marks the precipitation of a new series of γ mixed crystals varying in composition between the limits C (8.60 per cent. Si.) and C_1 (9.10 per cent. Si.). With more Si. than this, and up to 10 per cent. Si., the primary γ crystals are first formed, and at a uniform temperature of 815 deg. C. they solidify as the eutectic mixture of γ with the mixed crystals of the next series.

This series, which are designated δ, are deposited along the branch C, D, E of the liquidus, showing a maximum D at 853 deg. for the concentration 12.10 per cent. Si. Each of these two solutions undergoes a transformation, as shown in the diagram.

Slow Transformations.—All the alloys containing more than 12.10 per cent. Si. are subject after a time to a spontaneous alteration, which is accompanied by an alteration of volume, with a tendency to break into fragments. This alteration commences to manifest itself after several months, and would appear to be complete after about one year. It is also more predominant in those alloys the richer in silicon.

Conclusions.

The only maximum which is shown on the liquidus curves, and to which Rudolfi has assigned the formula Cu_4Si. is probably a compound, but the formula Cu_{12} Si_1 would appear to be more exactly in accordance with the results obtained in these experiments.

The γ crystals in a like manner are probably a definite compound, having the composition indicated by the formula Cu_{19} Si_1.

There is, however, still a considerable amount of doubt as to whether these are true compounds or simply solid solutions.

HEAT TREATMENT OF DURALUMIN ALLOYS.—According to a Paper by Messrs. P. D. Merica, R. G. Waltenberg, and H. Scott (published by the U.S. Bureau of Standards) the heat treatment of alloys of the duralumin type was investigated by them, and the effect observed of variations in the heat-treating conditions (such as quenching temperature, temperature of quenching bath) and of aging or tempering, and time of aging upon the mechanical properties. The temperature of quenching this alloy—they state—should not be above that of the $CuAl_2$, aluminium eutectic, which is usually about 520 deg. C., but should be as near to this as possible without danger of eutectic melting. The pieces should be held at this temperature from 10 to 20 min. and quenched preferably in boiling water. The hardening may for most purposes best be produced by aging for about five days at 100 deg. C. According to the authors' theory the hardening of duralumin during aging or tempering after quenching presents a close analogy with that of steel, and the evidence in support of their theory is of the same nature and of about the same competence as that in support of the prevailing theory of the hardening of steel.

The Steel Foundry at Vulcan Ironworks.

The steel foundry at the Vulcan Ironworks of Messrs. Thwaites Bros., Limited, Bradford, is the direct outcome of an intelligent anticipation of this country's requirements during the war, as previous to August, 1914, there was only quite a small iron foundry at the Vulcan Works. It was, however, apparent to the management that there would be a heavy demand for steel road wheels, a demand with which existing works would be wholly unable to cope. They therefore decided to lay down a steel foundry with a view to specialisation in the production of steel wheels. Within a few months of the outbreak of hostilities steel wheels were being cast and finished complete at Vulcan Works, though in the early days the company confined their operations to the output from a 10-cwt. Stock oil-fired converter, which, however, speedily had to give place to two electric furnaces of the Snyder type, each of 30-cwt. capacity. Meantime, the company had gained very valuable experience in the rapid and economical production of high-class steel wheels. This was duly recognised by the Ministry in 1916, when Messrs. Thwaites Bros. received imperative instructions to substantially increase their output. The existing (formerly the old iron foundry) foundry was already taxed to its limit. An entirely new foundry, with the necessary auxiliary shops, was therefore built, a third furnace was installed, and the foundry laid out for wheel casting, at the same time a machine shop was built and equipped with special machinery for the machining and finishing processes.

The foundry occupies a floor space of 200-ft. by 120-ft., and is covered by three bays. The centre is the casting bay, and this is served by three 5-ton Herbert Morris cranes. Moulding is done in the two side bays, each of which are served by two 5-ton cranes—Herbert Morris. Installed in the moulding bays are twelve Britannia jolt ramming machines, capable of taking boxes up to 15-cwt. There are also five hand turnover machines to take boxes from 8 to 10-cwt.; these machines were built by the company. In addition to the overhead crane equipment, each pair of moulding machines is served by a jib crane, the hoisting motions of which are electrically-driven; the cranes have lifting capacities from 10 to 20-cwt.

The quality of the sand is, of course, an important factor in the production of clean sand-castings; this, therefore, is a matter which receives very careful attention. The sand mixing shop is contained in an annexe off the side bay, 100-ft. by 26-ft., the equipment comprises six sand mills and a rotary dryer, which works on the continuous principle. Briefly, it consists of a circular pipe, which is revolved in a coke-fired furnace. All sand before being passed for use is subject to a rigid analysis. The whole of the patterns are made in gunmetal and are machined all over. Above the sand mixing shop is the core shop, intercommunication between the two floors being provided by an electric hoist.

The core shop contains twelve Thwaites core machines, and iron core-boxes are exclusively used. The two sand mills are driven by a Phœnix motor. Compressed air is injected into the oil tank to assist emulsification. There are eight Standard core ovens and a similar number of Portways portable ovens; these last are actually baking ovens, but they were all that could be obtained at the time of pressure, and appear to have served their purpose very well.

The three melting furnaces are placed at one end of the casting bay, with the transformer house immediately at their rear, and adjoining this last is the pattern stores. The Snyder furnace has previously been described in our columns; it has not come into very general use, mainly, no doubt, because it works on the single-phase system, and obviously an unbalanced load is not popular with power supply

companies. Of course, with three furnaces working together, the objection would not be so serious. However, at Messrs. Thwaites the furnaces are worked alternately so as to furnish a supply of metal every eighty-five minutes. Energy is taken from Bradford Corporation at 6,400 volts and transformed to 150 volts for use at the furnaces. In operation the furnaces appear to be very economical, the average consumption per ton of steel in the ladle being 680 units, with an electrode consumption of 6-lb.

The furnaces are acid lined. They are worked night and day for five days and up to 10 a.m. on the Saturday, when they are cooled off with a water spray and a veneer of bricks of the lining is renewed. The roofs are renewed twice a week. Each furnace melts during the week from 50 to 55 tons. This is not the full life of the lining, but the periodic repair eliminates the risk of having to shut down during the week.

It is interesting to note that all the lining bricks are soaked in tar. This soaking is done in the brick stores, where the bricks, after a preliminary drying in a coke-fired oven, are stacked upon trays and lowered into tanks of tar, which are heated by gas jets, the bricks are immersed for about three hours, in which time the tar has penetrated completely through. After draining they are scraped free from surplus tar and taken to the foundry. Two men are employed in the tarring; their output in all sizes being about 1,200 per week, with a tar consumption of about 30 cwt.

The treatment is said to practically double the life of the lining. The bulk of the material melted in the furnaces is turnings. This, during the war, amounted to about 80 per cent. of the whole, made up with the turnings from the machine shop and foreign turnings. From the machine shop the turnings are delivered down shoots into the basement, which is on floor level, where also the foreign turnings are tipped. The turnings, after being reduced by passing through a pan mill, are loaded into buckets, which are conveyed by aerial ropeway (Ropeways, Limited), across the yard to a tower above the foundry, where they are discharged, passing down a pipe to the basement below the furnaces, from which they are raised as required by the foundry crane. After casting the wheels are very carefully annealed, for which duty three coke-fired furnaces are in operation; two by the Incandescent Heat Company being 16-ft. by 4-ft. 6-in. by 4-ft. 6-in., and one built by the company 6-ft. by 6-ft. by 12-ft.

The wheels are then sandblasted, there being four Tilghmans' sand blasting apparatus installed, each 8-ft. by 8-ft. by 10-ft. high. They then pass to the fettling shop, around which is laid an overhead compressed air main, from which there are flexible downcomers to serve the pneumatic chippers, etc.

An Alley Maclellan compressor of 600 cub. ft. per min. at 100-lb., driven by 120-h.p. Phœnix motor, supplies air to the jolt rammers and pneumatic chippers, whilst each pair of sand-blast plants is served by a similar compressor, but with a working pressure of 30-lb., and each driven by a 35-h.p. Phœnix motor. In connection with the foundry, there is a well-equipped labpratory and test department, the last containing a 30-ton Buckton machine, Avery testing machine, and a Brinell Hardness testing machine.

In the matter of foundry and works control Messrs. Thwaites Bros. are responsible for interesting innovations. In the first place the whole of the foundry hands, including the skilled moulders, are on piecework, and the way this was brought about is worth recording. Some time back the company introduced a bonus system—a system, however, which did not differentiate between skilled and unskilled labour. The only means of adjusting this matter was piecework for all, and this the men readily accepted, and the result has been very satisfactory for all parties. So far as the company are concerned they are now getting 120 tons off the same floor as they were previously getting 40 tons, whilst the castings work out to 82 per cent of the steel in the ladle.

A Labour Register Department has also been formed to encourage and suitably recognise good time-keeping and good work. The method of working is, briefly, as follows:—A record is kept of each employee, and he is awarded points for:—Time keeping, maximum 100; efficiency—(*a*) based on time-keeping, 50 points; (*b*) work done, 50; broken tools, 24; spoilt work, 26; processes known, 25.

For each hour lost, other than for illness, 2 points are deducted. This is also the basis for (*a*) in "Efficiency," (*b*) is calculated upon the percentage of work done up to 100 per cent. over standard. For "broken tools," 2 points are deducted. For "spoilt work," 1 point is deducted for each hour spent in doing that work. "Processes known" has been introduced so as to maintain the proper relationship between the highly-skilled and the semi-skilled and unskilled man, otherwise the man engaged upon repetition work would naturally have an advantage. At the end of each quarter the points are totalled up and every man who obtains 85 per cent. of the possible receives an increase in wages in accordance with his scale of pay over the next thirteen weeks; this increase being given from quarter to quarter so long as he maintains his percentage.

Finally and by no means the least important there is the Workshop Committee, whose functions are set forth in the rules as follows:—

The Committee shall be composed of a delegate from each department of the works, who will be elected by the workers of each department.

The officials of the Committee shall be elected from the whole of the delegates. The officers shall be as follows:—President, vice-president, treasurer, secretary, assistant secretary, convenor of the Committee.

The term of office for the officials and delegates shall be for a period of 12 months, when a further election will take place.

Committee meetings will be held the first Monday in each month at 4.30 p.m. in the Works Committee Room.

The functions of the Committee shall be:—

(*a*) To hear and discuss all complaints from employees, or differences of opinion arising between them and the representatives of the employers, with a view to avoiding disputes, and arriving at a mutually satisfactory agreement.

(*b*) To study the working conditions of the shop and the welfare of the workers, with a view to making suggestions to the employers for their improvement.

(*c*) To promote and maintain a feeling of harmony between employer and employed, for the general well-being of the whole works.

All complaints and suggestions must be placed in the hands of the delegate of the department, duly signed by the person or persons concerned, in time to be passed on to the secretary before 12 noon on the day of the monthly meeting.

The Committee will consider these complaints and suggestions, and the delegate of the department, together with the secretary, will first approach the foreman with a view to a settlement. If this is not obtained, they will approach the works manager. Failing settlement, the matter will be referred by the Committee to the management.

A deputation of five, chosen from the full committee, together with the secretary, will interview the management when required. It must be understood that no official or delegate will be allowed to approach the management alone.

It is advisable, in order to save friction between the management and the Committee, that employees should not visit the secretary during working hours, except in cases of emergency.

The Committee will not deal with any matter which is brought to their notice through channele outside the works.

The Committee shall have power to exclude any delegate who does not comply with these rules

Centrifugally-Cast Pipes in South America.

Progress in the application of the centrifugal process for making iron castings has been rapid in the last year or two. The first description of this principle, as applied to cast-iron pipe, appeared in "The Iron Age,"

FIG. 1.—SHOWING THE UNUSUAL METHOD OF TAPPING METAL FROM THE CUPOLAS.

September 7, 1916, when the De Lavaud machine was described, and reference was made to the commercial use of the process in Brazil.

of the metal. Since the description referred to there have been two other accounts of the developments of this process, which was invented by a Brazilian, D. Sensaud de Lavaud of Sao Paulo, Brazil. In "The Iron Age" of November 29, 1917, there was published a short description of a new plant, using a further development of this machine at the National Iron Works, Limited, at Toronto, Canada. At that time, 6-in. pipe 10 ft. long was being successfully produced at the rate of 20 to 25 per hour. Since then, however, the process has been extensively developed, so that results far exceeding these have been achieved.

A more recent application of the De Lavaud principle has been the manufacture of cast-iron piston rings in a special machine. This was described in detail in "The Iron Age," October 3, 1918. According to that description it was possible to produce 18,000 to 20,000 piston rings per day, rings that possessed unusual mechanical and physical properties.

In the last two or three years two companies have been organised for commercialising this centrifugal process in general. One of these is the Centrifugal Cast Iron Pipe Company, of New Jersey, which controls the patent rights in North and Central America, and the International De Lavaud Manufacturing Corporation, Limited, with headquarters in Toronto, Canada, which owns all the rights in the remaining countries of the world. Of immediate interest is the recent installation in Brazil and Argentina of two new plants using on a large scale this process of making pipe.

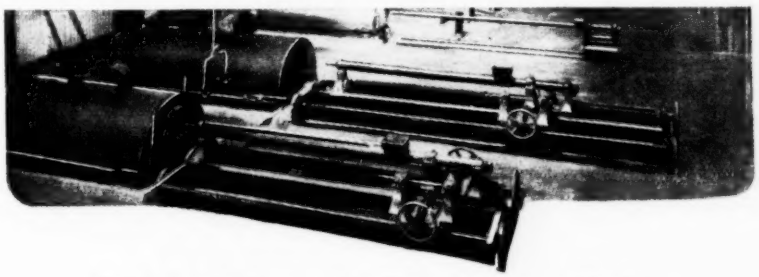


FIG. 2.—GENERAL VIEW OF CENTRIFUGAL PIPE-CASTING MACHINES.

The new development in cast-iron metallurgy involves the use of a very rapidly revolving metal mould into which is mechanically introduced, while still

A subsidiary company of the International De Lavaud Manufacturing Corporation is the Brazilian Corporation, Companhia Braziliera de Metallurgia, located at Sao

FIG. 3.—SHOWING METAL BEING POURED INTO THE MACHINES, AND A FINISHED PIPE WITHDRAWN.

revolving, very hot molten iron of proper composition. A completely finished pipe is removed from the machine, which is distinguished for its uniform thickness, for its unusual strength in proportion to its cross section, and for the rather remarkable properties

Paulo, Brazil, and which supervises all the South American patent interests. A pipe-casting plant has been erected in one of the suburbs of Sao Paulo, and the plant covers an area of about 10 acres. There are 20 different De Lavaud machines now in operation at

this plant, producing about 25 metric tons of pipe daily. With the equipment on hand, however, the capacity may be increased to 100 tons daily.

The iron is melted in three cupolas. The pig-irons used are made from the ore mined in Minas Geraes, Brazil, and imported pig-iron. The mixture used contains 30 per cent. national or Brazilian pig-iron and 70 per cet. imported iron. It is expected by some that the iron industry of Brazil will find available in the near future native pig-iron in larger quantities so as to supply other South American Works.

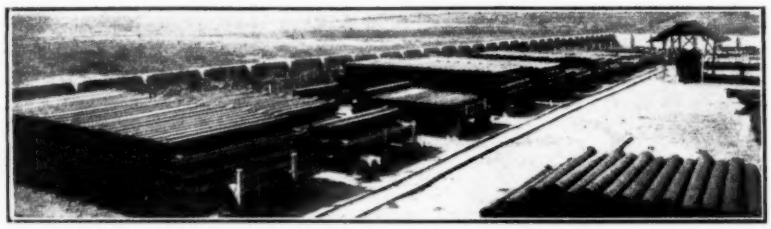


FIG. 4.—STOCKS OF CENTRIFUGALLY-CAST PIPES IN THE YARD OF THE BRAZILIAN PLANT.

Corrosion and Stainless Steel.

A Paper entitled "Some Notes on Corrosion of Metals" was given by MR. W. H. J. VERNON before the Birmingham Metallurgical Society on October 16. Mr. F. C. A. H. Lantsberry (President) was in the chair.

THE LECTURER, with the aid of micro-photographs and other slides, dealt with the genesis of corrosion, together with some of the most important factors influencing its subsequent course. He laid particular stress upon electro-chemical action as relating to the practical problems of corrosion, and quoted an example of the fracture of a propeller shaft brought about by the type of corrosion. A demonstration was given of the action of internal galvanic couples in effecting the corrosion of metals and alloys. But, said the lecturer, whilst in the light of the electrolytic theory perfect homogeneity should ensure freedom from corrosion, non-homogeneity—still without defection from the theory—did not necessarily stand for non-corrodibility. A good example was afforded by the well-known "stainless" steel.

The latter part of the lecture was devoted to some experimental investigations Mr. Vernon had made upon the corrosion of extruded brass rods partially immersed in acid solutions of salts. He had found the destructive action at the water-line to be increased largely by the presence of certain salts, and also by rise of temperature. The action of light was found to set up a curious type of electro-chemical corrosion. Suitable annealing was shown to reduce water-line corrosion. The action on the metal was shown to be that of dezincification of the brass from the surface inwards, acting preferentially on the Beta constituent. Thus the metal retained its external form even when it had been very largely converted into copper. The latter, however, when the action had proceeded sufficiently far, was easily detached from the inner core of uncorroded brass.

In a discussion which followed, DR. AITCHISON said that Mr. Vernon, in his references to steel, unfortunately omitted to say that stainless steel was not stainless on a section which had been left quite rough. It was only stainless if it was carefully polished. He had investigated many steels, including stainless steel, on various occasions, and as a result of his work had advanced the theory that the lack of corrosion of stainless steel was due to the fact that the various constitutents had the same or very nearly the same solution pressure. But if that theory was true, how was it that an ordinary cut surface of stainless steel did corrode, whereas a surface which had been properly polished, and having apparently the same microscopic structure, did not corrode? That, he thought, struck very hard at the root of the theory which Mr. Vernon had put forward.

MR. A. J. G. SMOUT pointed out the importance of avoiding even minute scratches and spills, as these were likely to form corrosion points. The ordinary works pickle caused a tendency to corrosion, and his firm some time ago carried out experiments as the result of which the successive stages of annealing could be carried out without resort to pickling.

MR. F. JOHNSON passed round samples of corroded condenser tubes, and of others with internal deposition of scale. One of the latter showed a diminution of internal area of 58 per cent. The fact that a drawn-brass bar, was found more resistant to corrosion than one merely extruded, was due apparently to the better surface produced by passing the bar through the die. With regard to stainless steel, he (Mr. Johnson) believed that even a polished surface of stainless steel would be corroded by certain solutions, for instance, one of hydrochloric acid.

DR. AITCHISON said that Mr. Johnson was quite correct in saying that a polished surface of stainless steel was very readily attacked by hydrochloric acid. In a 10 per cent. solution of sulphuric acid stainless steel dissolved much more readily than did ordinary plain carbon steel. He had examined specimens containing chromium from 0 per cent. up to 25 per cent., submitting samples of each to attack by ordinary tap water, by sea water, by 2 per cent. sulphuric acid, and by 10 per cent. sulphuric acid. The corrosion curves for sea-water and for 2 per cent. sulphuric acid were almost exactly alike. There was a slight increase of corrosion as the chromium content began to increase, then there was a falling off to zero, and then again a very slight increase as the chromium was increased further. With a strong solution of sulphuric acid they got very different curves. Stainless steel, which was not attacked at all by water or dilute acid or sea water, was attacked very much by the strong solution of sulphuric acid. It would dissolve the steel at a tremendous rate, but the action did not commence at once. The steel might be left in the solution for six hours without the slightest action being observable; then the thing would go "pop," and there was a tremendous activity, and the steel dissolved at a terrific rate. Hydrochloric acid, in equivalent solutions, gave almost exactly similar effects.

MR. VERNON, in the course of his reply, said that though he did not claim that the electrolytic theory was absolutely complete as an explanation of all corrosion, it was important that practical men should recognise the distinct danger of having dissimilar metals in contact in circumstances which would cause them to form

HY. WHITE & COMPANY, LIMITED, Pontymister Foundry, Risca, were fined £50, including costs, at Newport recently, for not fencing an electric crane in the moulding shop, in consequence of which a man was killed on September 26 last.

The Shimer Case-Hardening Process.

The Shimer case-hardening process, a war emergency invention, is a "liquid" process, employing a bath of fused salts, in which the object is immersed.

Of the liquids hitherto used as baths, the most effective and most frequently used are melted potassium cyanide and melted sodium cyanide, either pure or mixed with salts to reduce the melting point and the percentage of cyanide present. The use of these baths since 1914 has met with many kinds of difficulties because of the high price and frequent commercial scarcity of the cyanide salts; at present sodium cyanide has practically entirely displaced potassium cyanide. Another trouble is the danger from handling the cyanide salts, which are extremely poisonous, and the annoying gases or vapours given off, unless an effective system of hoods and ventilation is provided, so as to prevent the gases from the baths mixing with the air of the workshop.

Mr. Porter W. Shimer, of Easton, Pa. (U.S.A.), has now invented and patented a substitute for the bath of melted cyanides which case-hardens with equal or greater facility and effectiveness, gives off no poisonous vapours, and costs for chemicals materially less than the cyanide does in the previously used baths. The process has been in use for over a year in a large American works, and the following statement by Professor Joseph W. Richards, of Lehigh University, in a Paper published in a recent issue of the Bulletin of the American Institute of Mining Engineers, embodies the results of practical experience in the use and operation of the process.

The Shimer liquid or melted bath consists of a mixture of easily fusible salts that do not possess themselves case-hardening properties, in which is immersed fresh calcium cyanamide, which imparts to the bath such properties. The composition of the non-case-hardening salts appears rather immaterial. Good results have been obtained by using a mixture of sodium chloride, calcium chloride, and barium chloride in equal proportions by weight; also a mixture of one part of sodium chloride to one part of calcium chloride. Potassium chloride can replace the sodium chloride where the question of cost is not material, producing a very liquid bath when equal chemical parts of the two salts are used; that is, 58.5 parts of sodium chloride to 75.5 parts of potassium chloride. Alkaline carbonates or alkaline hydroxides have also been added to the bath, with advantage in some special cases.

This mixture of non-case-hardening salts is melted in an iron or steel pot suitable for case-hardening operations, and the calcium cyanamide is brought into contact with it, which may be accomplished in several ways. One effective method is to place small lumps of the cyanamide in an iron basket, which is sunk to the bottom of the case-hardening pot. A lively evolution of gas soon takes place, the exact composition of which has not yet been fully determined. The bath quickly acquires case-hardening properties, which last as long as the evolution of gas continues. What the exact chemical reaction of the cyanamide upon the non-case-hardening salts is to produce a melt that has excellent case-hardening properties has not yet been determined; it would need thorough and arduous chemical investigation to illuminate precisely the rationale of the operation. The active evolution of gas is a valuable feature of the process; it keeps the bath in circulation, and thereby equalises its temperature, it accelerates the heating and case-hardening of objects immersed, and, finally, it is an indication to the workman that the bath is in working order, with active case-hardening properties.

In practice, the calcium cyanamide is immersed in the bath of melted salts, and as soon as a lively evolution of gas is shown, the dipping in of articles and their case-hardening can be proceeded with. If the evolution of gas becomes too active, the cyanamide may be removed, and case-hardening can be proceeded with for some time after this removal. When the case-hardening power of the bath decreases, the cyanamide may be re-immersed, and the operation continued. If the cyanamide is in large, fresh pieces, and the evolution of gas is not too violent, the cyanamide may be left in the bath until it has lost its power, as is shown by the diminution of the evolution of gas. On removing this apparently exhausted material, the larger pieces may be broken, thus exposing fresh surfaces, and the material will be found still to retain active properties when re-immersed in the bath.

It has been found that the cyanamide is best used in lumps varying from the size of a walnut to that of an egg. It should be in the fresh condition as it is taken from the furnace; that is, it should be kept hermetically sealed until used. If fine powder is put into the bath, it is difficult to keep it immersed, and the frothing is voluminous and troublesome. If the cyanamide has been exposed to air, absorbing moisture and becoming oxidised, it causes violent frothing when immersed in the bath, which continues an inconveni ently long time. If only such cyanamide is available, it may be mixed with pulverised hard pitch or with tar, and the mass coked at a red heat; this eliminates absorbed moisture, and changes the structure from powder to a porous coke. Such coke is then used in the melted salts in the way described for solid lumps of fresh calcium cyanamide.

The quantity of cyanamide immersed will vary according to the size of the bath and the shape, size, and character of the articles to be case-hardened. A bath may have immersed in it 5 per cent. of its weight of the fresh calcium cyanamide, or a corresponding quantity of the cyanamide coke, for ordinary work.

THE CHAIRMAN (the late Mr. J. E. Johnson, Jr.), in opening the discussion before the Institute, said that sodium cyanide is now being made commercially by melting together in an electric furnace calcium cyanide with common salt, which produces calcium chloride and sodium cyanide. It seemed to him quite possible that we had here about the same results that would be obtained by melting calcium chloride and ordinary cyanide together, only it could be obtained much cheaper.

PROF. J. W. RICHARDS said the opinion of Mr. Landis, of the Cyanamide Company, was that probably sodium cyanamide was produced, and went into the bath. There was no direct evidence that there was cyanide in the bath. The calcium chloride of commerce, with its possible impurities, should be carefully selected, so as to see that the right quality is obtained.

MR. P. W. SHIMER, the inventor of the process, in a written contribution, stated that when lump calcium cyanamide was immersed in the melt of mixed chlorides of the alkalies and alkaline earths in the manner described in the Paper, the amount of sodium cyanide formed in the melt, as shown by numerous analyses, was but a small fraction of that formed by the reaction referred to by Mr. Johnson. The much lower melting point (about 121 deg. C. lower) of the mixed chlorides, their cheapness, and their freedom from deterioration after long use in the melting pot, are important advantages. The freedom from deterioration of the bath is due to the fact that the melt simply combines with, and dissolves, case-hardening compounds from the lump cyanamide, leaving all residual lime, carbon, etc., in the lumps, which are lifted out with the basket when the cyanamide is exhausted.

THE following licences have been granted under the Non-Ferrous Metal Industry Act, 1918:—Ahlmann, Otto Frederick, 35, St. John Street, E.C.1; Buckeridge, Covell & Company, 60, Mark Lane, E.C.3; Cronite Foundry Company, Limited, 5, Victoria Street, S.W.1; Johnson, Frederick Harold, 12 St. Wilfred's Road, New Barnet, Herts.

Richards-Kane Heat-Treatment Furnace.

We illustrate a furnace built on the Richards-Kane patent system, which is in service for annealing in the forge at a works in South Wales. It will be seen from the sectional illustration that the producer A is built into the rear of the furnace structure, the gases passing through the ports B into the mixing chamber C, where they meet and become intimately mixed with the pre-heated air before passing down through the port D, where combustion takes place over the furnace hearth E, the products being afterwards drawn off through the downports F and into the passage G, at the end of which they enter the chimney flue H. The secondary air enters at I, passing along under the passage G and through the air course J, at the end of which it takes an upward course through the series of openings K,

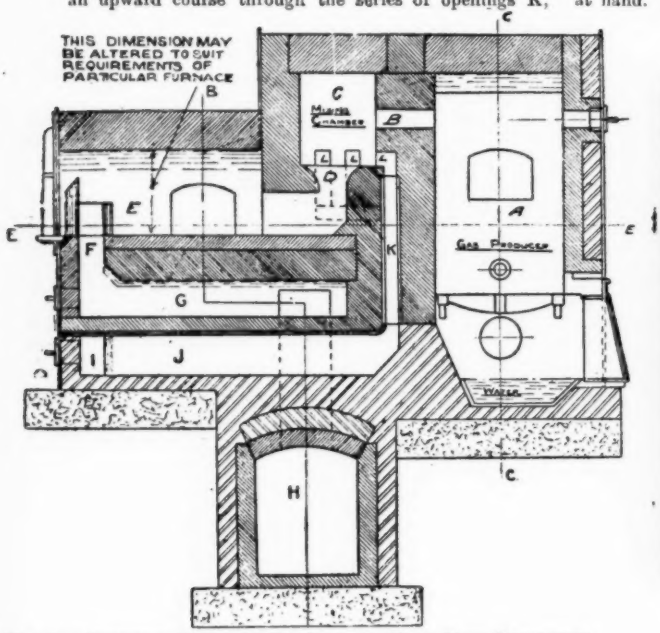


FIG. 1.—SECTIONAL VIEW OF THE RICHARDS-KANE HEAT-TREATMENT FURNACE.

deriving heat on the one side from the producer walls and on the other from the wall of the furnace chamber. The air continuing its course enters the mixing chamber through a series of small ports which are arranged on three sides of the chamber. Regulating dampers are provided, by the simple manipulation of which any desired temperature and working condition may be secured. A neutral, oxidising, or reducing atmosphere may be obtained at pleasure.

It will be seen that the furnace is constructed on very simple lines free from a complication of flues and passages liable to obstruction. The furnace is under perfect control, and suitable provision is made for ready access to all parts that require attention from time to time. Mr. E. Windsor Richards, Castle Chambers, 65, Renfield Street, Glasgow, was responsible for the erection.

MR. J. DAVIS has established himself in business as a consulting engineer at 64, Victoria Street, Westminster, S.W.1. He has resigned his position under the New South Wales Government.

Operating under Difficulties.

An article, by Ivan Lamoureux, in "The Foundry," states that most of the foundries in the Liége district in Belgium had to stop work in 1916 by order of the German authorities. Among those which remained inactive were some of which the invader was unaware, some whose production was needed for useful public work, and finally those that involuntarily or otherwise assisted in the foundry work required for the support of the German army. Despite the complete stoppage of large industries and the absence of raw materials, other than those which were to be found in Belgium, and which had escaped the enemy requisitions, small iron foundries continued secretly to cast small machine parts and all kinds of hardware. Foundries which were prevented from operating their regular shops built small improvised cupolas from materials at hand. These were hidden away and operated clandestinely. They ranged from 8 to 13 feet high and were only 12 or 18 inches in diameter. Some were built with a square section. During the German occupation, gas and electricity were strictly limited. It was impossible to secure current to operate motor blowers. For this reason all kinds of makeshifts were frequently resorted to for operating the cupola fans. In one case a bicycle was converted into a stationary power unit. The front fork was removed, the machine inverted and firmly anchored and the back wheel was belted to the drive pulley of the blower. The cranks to which the pedals had been fastened were extended to double the former length and wooden handles replaced the pedals. Two men turned this power unit, three shifts of two men each taking turns in turning the cranks to operate the blower. The melting period of the small cupola was two hours with a fan speed of as high as 2,000 revolutions per minute. In ordinary practice a 1-horse-power motor served to drive a blower of the type in question. These small hidden foundries operated practically during the entire war, making door hardware, furnace grates, small coffee and flour mills and other mechanical devices and hardware products which at that time were in great demand.

FIG. 2.—GENERAL VIEW OF THE RICHARDS-KANE HEAT-TREATMENT FURNACE.

Vacuum Ovens for Drying Cores.

In the ordinary core-oven operated at atmospheric pressure, greater oven capacity is needed on account of the slowness of drying than is required with one of the vacuum type, says a writer in "The Foundry," who proceeds to describe a suitable design for drying cores.

Fig. 1 is a sketch of a proposed battery of three vacuum-drying core ovens. They are supposed to be made of boiler steel, air-tight and of sufficient size for the purpose. The cylindrical form will withstand the atmospheric pressure without buckling, when under a high vacuum. They are

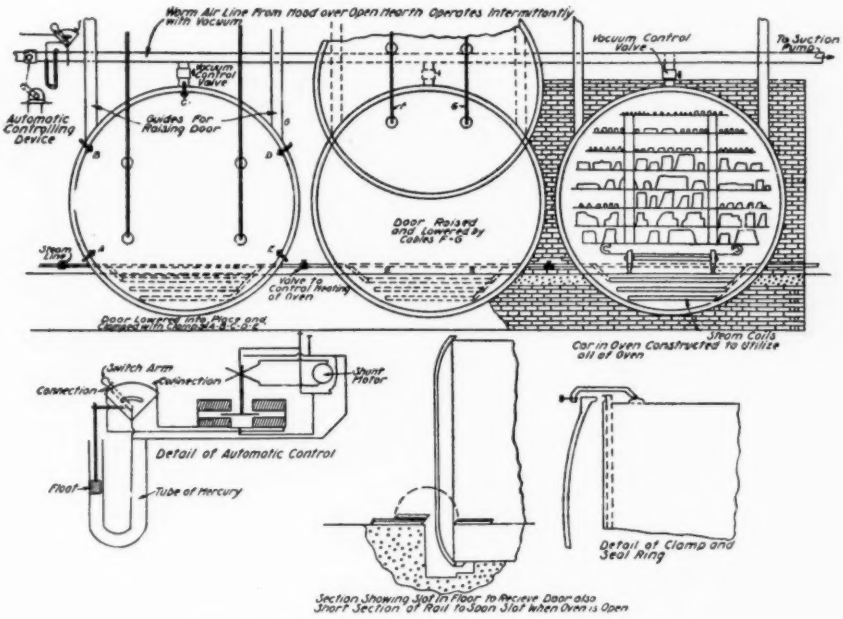

Warm Air Line From Hood over Open Hearth Operates Intermittently with Vacuum
Vacuum Control Valve
To Suction Pump
Automatic Controlling Device
Guides For Raising Door
Door Raised and Lowered by Cables F-G
Steam Line
Valve To Control Heating of Oven
Steam Coils all of Oven
Switch Arm
Connection
Shunt Motor
Detail of Automatic Control
Float
Tube of Mercury
Detail of Clamp and Seal Ring
Section Showing Slot in Floor to Receive Door also Short Section of Rail to Span Slot when Oven is Open

FIG. 1.—ARRANGEMENT OF THREE DRYING OVENS.

heated by live steam producing a temperature of 250 to 275 deg. Fahr. in the ovens. Each oven is connected to the main exhaust line at the back and top, and can be shut off from connection with the system when being unloaded or unloaded, by turning the connecting valves. An exhaust pump is connected to one end of the exhaust line and on the other end is a rotary valve operated by a shunt motor, which automatically opens the valve when the mercury in the tube, shown to the left of the figure, reaches a predetermined height of vacuum. As soon as this valve opens, it allows dry warm air (supplied from metal melting furnace) to be drawn into the ovens, to replace the moisture-laden air drawn out by the vacuum. When the vacuum is released by the inrush of warm air, the mercury drops in the tube to atmospheric level and closes the reverse circuit by means of the other contact, thus reversing the motor, which again closes the warm-air valve.

The air pump is continually running, and when the valve is again closed, the air in the ovens is exhausted until the mercury reaches the point at which it again closes the circuit. This operation is repeated periodically and automatically during the time of drying, causing the boiling-point of the water to be lowered to approximately 115 deg. Fahr., with about 26 in. of mercury.

The doors are of cast or pressed steel and hung on cables as shown. An air-tight joint is made by a composition of asbestos in the outer run of the casing, and the door clamped tightly with the clamps illustrated. This could be quickly done after each loading. The doors would be swung up, out of the way on the cables during the loading and unloading operations.

The ovens could be placed inside existing ovens, using the latter as insulators to prevent loss of heat, cutting out the bottoms to bring the steam heating coil below the floor level and to allow the perforated bottom and tracks to coincide with the general floor level.

Comparative drying tests on small cores of the same size, made from the same batch of sand, show that vacuum drying at 250 deg. Fahr., with 18 in. of vacuum, was complete in from 15 to 25 minutes, while cores dried in a gas oven at 350 deg. Fahr. took 45 minutes to completely dry them. This was ascertained by weighing the cores until a constant weight was reached. The only difference in the drying is that the gas-oven-dried cores had the bond more completely oxidised than the vacuum-dried cores. But as this oxidisation need not necessarily take place in the oven, the time saved in vacuum drying is apparent.

XUM

Trade Talk.

THE gun factory at Burton-on-Trent has been released for sale.

THE new steelworks at Coatbridge of the Scottish Iron & Steel Company, Limited, are now in operation.

THE resolutions increasing the capital of the Bengal Iron and Steel Company, Limited, have been confirmed by the shareholders.

MR. JOHN G. SCOTT has established himself in business at 42, Frederick Street, Edinburgh, as an iron and steel merchant.

RICHARDS, TURPIN (MINERALS), LIMITED, are taking over the business of Messrs. Wm. Turpin & Company, Gloucester House, Swansea.

AN explosion in a blast furnace at the Apedale Works of the Midland Coal, Coke and Iron Company, injured six men, two very seriously.

BRADLEY & FOSTER, LIMITED, have removed their London offices from 5, Chancery Lane, W.C.2, to Kingsway House, Kingsway, W.C.2.

THE BARROW HEMATITE STEEL COMPANY, LIMITED, have issued privately a further £400,000 of their 5 per cent. free of income-tax debentures at 101½.

YATES & THOM, LIMITED, Blackburn, have purchased the Phœnix Foundry, Lancaster, which has belonged to Messrs. Sharpe & Company for fifty years.

BOLCKOW, VAUGHAN & COMPANY, LIMITED, are proposing to establish chemical works on Middlestone Moor, midway between Bishop Auckland and Spennymoor.

MESSRS. WESTOBY & RAWSTRON, iron and steel merchants, have removed from the Produce Exchange to more commodious offices, 326 and 327, Royal Exchange, Manchester.

CONSIDERABLE progress is being made in connection with the formation of the Institute of Transport, of which Sir Eric Geddes, Minister of Transport, is the first president.

THE AMERICAN ZINC PRODUCTS COMPANY, of Greencastle, Indiana, have appointed Messrs. Samuel, Sons & Benjamin, 16, Philpot Lane, London, E.C., as their European agents.

THE works of the Witton Engineering and Storey Metals, Limited, have been removed from Newtown Row, Birmingham, to Wilder's Drive, Warwick Road, Greet, Birmingham.

WOOLWICH ARSENAL is to be developed as a centre for the construction and repair of wagons and engines in order relieve the great scarcity of wagons and rolling stock generally.

THE number of vessels launched on the Tyne during November was six, of an estimated register tonnage of 13,528, as compared with eight, of 20,023 tons, for the corresponding month of last year.

THE TAYLOR FILE AND TOOL COMPANY, LIMITED, have established a factory at Farnley, Leeds. It is understood that the company have acquired the Stead process for the rapid production of round blanks.

W. H. DORMAN & COMPANY, LIMITED, engineers, of Stafford, propose to make extensive additions to their works, and for this purpose are negotiating for the purchase of no fewer than 46 acres of land in the neighbourhood of Stafford.

THE men at the Mill Close Lead Mine, Darley Dale, who have been on strike for some months, have claimed three disused lead mines under the ancient Peak mining laws, which they will proceed to work as soon as the plant can be obtained.

AN interesting lecture on "Testing of Sheet Metals" was delivered on December 12 by Dr. A. G. C. Gwyer, of Warrington, in the Mappin Hall of Sheffield University, before members of the Sheffield Section of the Institute of Metals. Mr. W. R. Barclay presided.

MR. EUGENE SCHNEIDER, the president of the Iron and Steel Institute, has proposed that the Institute should hold its next autumn meeting in France, and although the matter is not yet definitely settled, discussions concerning the possible arrangements are on foot.

IN a paper by Mr. F. A. Matthewson, Sheffield, read at a meeting of the West of Scotland Iron and Steel Institute, held in the Royal Technical College, Glasgow, the problem was dealt with of the prevention of the absorption of sulphur in the melting of steel scrap.

THE SHIPPING CONTROLLER has invited British shipowners who find difficulty in placing orders for the construction of steamers in British yards to communicate with him at the Ministry of Shipping, St. James's Park, S.W., giving full particulars of their requirements.

THE MONOMETER MANUFACTURING COMPANY (1918), LIMITED, have removed their works from Whitehouse Street to Browning Street, Birmingham. The Monometer Company are also the proprietors of the Griffin Ironworks and Albion Foundries, Browning Street, Birmingham.

AT a meeting of the Birmingham Section of the Institute of Metals, held at the Chamber of Commerce on December 16, Mr. F. S. J. Pile, who is director of the laboratories of the Midland Laboratory Guild, submitted a paper on "Brass, its Construction and Impurities."

DURING the eleven months of last year 59 vessels have been launched from Wear shipyards, aggregating 248,223 tons. Last year the twelve months' output aggregated 60 vessels of 267,757 tons. For the month of November four vessels of a total tonnage of 18,208 were launched.

UNDER the title Société Anglo-Belge de Construction, a society has been formed with a share capital of 2,000,000 francs (4,000 shares of 500 francs each). The Compagnie Générale de Chemins de Fer Secondaires and the English firm of S. Pearson & Son have each taken up 1,950 shares.

JOSEPH KAYE & SONS, LIMITED, have been the sole contractors to the British Navy for oil feeders and spouts for the last sixteen years, and during the period of the war they supplied 233,545. The company have recently received a further order from the Admiralty for 13,152 of these oil cans.

THE shareholders of the Port Talbot Graving Dock & Shipbuilding Company, Limited, have passed resolutions increasing the capital of the company to £100,000 by the creation of 30,000 new ordinary shares of £1 each, and that each of the existing 7,000 shares of £10 each be divided into ten shares of £1 each.

CLAYTON & SHUTTLEWORTH, LIMITED, of Lincoln, have received orders for four "Clayton" 5-ton end-tipping steam wagons, from the North Riding C.C., and one from each of the Chesterfield R.D.C., Eston U.D.C., West Hartlepool Corporation, and the Westmorland C.C.

NEGOTIATIONS are proceeding for the amalgamation of the Dominion Steel & Iron Company, the Nova Scotia Steel & Coal Company, the Steel Company of Canada, and Canada Steamships, Limited. The combined capital stock and funded indebtedness of these four corporations amount to more than $1,500,000,000.

THE Scottish shipbuilding returns for November show that 26 vessels were launched on the Clyde, with an aggregate tonnage of 54,183, as compared with the October tonnage of 37,282. The output for the eleven months of the present year was 503,655 tons, a reduction of practically 120,000 tons as compared with 1913.

IN the course of a statement made at a political meeting at Glasgow, Mr. Bonar Law referred to the question of housing. Of the schemes considered, he said, one of the most feasible was that of a steel house, which could be built more rapidly and more economically than ordinary houses. These were to be tested.

AUTOMATIC & ELECTRIC FURNACES, LIMITED, inform us that after lengthy experiments they have succeeded in obtaining a non-porous metal container for their electric salt bath furnaces, which permits the current to be switched on and off as and when required. With

current at one penny per unit a ton of tools can be hardened for the cost of £2 4s.

An amalgamation has been arranged between Turner Brothers Asbestos Company, Limited, Rochdale, the Washington Chemical Company, Limited, Washington Station, Co. Durham, and Newall's Insulation Company, Limited, Newcastle-on-Tyne. Each company will maintain its name and present policy, while the directors and staff will continue unchanged.

To utilise to the fullest extent the productive capacity of their extensive works at St. Peter's, Newcastle, the directors of R. & W. Hawthorn, Leslie & Company, Limited, have created a special locomotive department at their riverside establishment. The firm have been engaged for many years in building locomotive engines and boilers at their Forth Bank Works.

Mr. W. D. Lloyd has resigned his position with Sutton & Ash, Limited, of Birmingham, with whom he has been associated for the past 25 years, and of which firm he has been a director since its formation into a limited company. Mr. Lloyd has joined the management of Adams & Benson, Limited, iron and steel merchants, Albion, West Bromwich.

During their short official visit to this country, the Uruguayan Mission inspected the new locomotive works and the shipyards of Sir W. G. Armstrong, Whitworth & Company, Limited. At the shipyards they had the opportunity of seeing the Cunarder "Aquitania," the longest vessel which has ever entered the Tyne, which is now undergoing reconditioning and fitting out.

The Cunard Steamship Company have placed the order with Grigham & Cowan, Limited, of South Shields, to fit out the "Aquitania" with the White patent low-pressure mechanical oil-burning system. The same firm also have the contract to supply the White system for the Transatlantic liner "Olympic," now being reconditioned at Messrs. Harland & Wolff's yard.

Mr. E. J. Bradley, lecturing before the Leeds Association of Engineers, on "Organisation and the Science of Management," expressed the view that engineering works in Leeds generally had not reached the point of efficiency in regard to methods of progressing and planning works in the shops which would be one of the necessities in English works in the future.

Mr. Balfour presided at a conference on research organisation, held at the Institution of Civil Engineers, under the auspices of the Department of Scientific and Industrial Research, when two papers were read, one on the subject of "The Equipment of Research Laboratories," by Mr. Lawrence Balls, and the other on "Research Associations and the Collecting and Indexing of Information."

Mr. W. Hope Wilson, for many years general manager of the H.S. engine and turbine department of James Howden & Company, Limited, and who formerly held a position with Willans & Robinson, Limited, has commenced business as a consulting engineer at 29, St. Vincent Place, Glasgow. In addition to consulting work generally he will specialise in steam turbines, engines, boilers, and electrical power plant.

Extensive shipbuilding developments were forecasted by Sir Hugh Bell, the chairman of the Tees Conservancy Commission, at a recent meeting of the Commission, when it was stated that there had been a sale of 82 acres of foreshore to Smith's Docks Company, Limited. Arrangements had, it was stated, also been made for the sale of eight acres of land to William Gray & Company, Limited, West Hartlepool, at £400 per acre.

The Board of Trade inquiry has been concluded relative to an explosion in a steam chest when a locomotive safety valve was being tested at the Barrow shipyard, resulting in two deaths. Mr. A. A. Hudson, K.C., in giving judgment, said that to carry out this steam test a vessel was used that was not suitable, and the foreman was to blame for the explosion for not carrying out a water test of the vessel before it was steam-tested. There was no blame attached to Vickers, Limited, in whose works the explosion took place. No order was made as to costs.

Mr. R. T. Nugent, the Director of the Federation of British Industries, has just returned from a visit to the office of the Federation's Trade Commissioner in Madrid. He was accompanied by Mr. C. F. I. Ramsden, who visited Valencia and Barcelona to inquire into the proposed exhibitions to be held in these two places. The mere fact of the arrival of the Federation with a suitable commissioner, competent staff and an office in the best centre of Madrid, has, it is claimed, been a valuable collective advertisement for British industry in general.

The announcement was made recently that an offer to purchase the whole of the ordinary shares in James Dunlop & Company, Ltd., had been made to the firm. We understand that the offer was submitted on behalf of Lithgow, Ltd., shipbuilders, of Port Glasgow, who own or control six shipbuilding yards in Port Glasgow, and also the large engineering works of David Rowan & Company, Glasgow. The price of 40s. per share was offered, and acceptances having been received to an extent that met the wishes of Messrs. Lithgow, the bargain has now been concluded.

The exhibit of A. Reyrolle & Company, Limited, at the recent British Science and Key Industries Exhibition, in Glasgow, covered a space of 25 ft. × 11 ft. Among the articles exhibited were samples of Reyrolle armoured switchgear for use on voltages from 500 up to 20,000, including a duplicate of the 20,000-volt sub-station equipment for the Glasgow Corporation, in every way similar to that supplied by them in 1912 13 to Chicago and the Canada Cement Company. There were also other samples of the company's mining switchgear, self-aligning fuses, distribution boxes, wall plugs, etc.

Sir Hallewell Rogers, chairman of the Birmingham Small Arms Company, Limited, announces that the directors have succeeded in making provisional arrangements for the issue of 12-year notes to the aggregate amount of £2,500,000, carrying interest at the rate of 6½ per cent. per annum. He recalls that he outlined at the annual meeting of shareholders in October last a broad policy of development for the company, which was approved by the shareholders present. In pursuance of this policy it was evident that the company would require increased financial resources, both in respect of acquisitions already made and to provide for further extensions in the future.

A new draft deed of constitution was adopted at a meeting of the South Wales and Monmouthshire Iron and Steel Manufacturers' Association, held at the Engineers' Institute, Cardiff, recently. Mr. H. R. Jones, J.P., general manager of the Dowlais and Cyfarthfa Works and Collieries, was elected chairman for the ensuing year, and Mr. J. H. Lones, general manager of the Blaenavon Works and Collieries, was elected deputy chairman. Mr. F. Mills, J.P., D.L., who has been recently elected chairman of the Ebbw Vale Steel, Iron and Coal Company, Limited, and therefore retires from active connection with the Association, was thanked for his valuable services to the Association over a long period of years.

The new shipbuilding yard established at Belfast by Harland & Wolff, Limited, is almost completed. The yard occupies a site of 33 acres, and meantime it will have six building berths, capable of taking vessels up to 1,000 ft. in length. In addition, there is a platers' yard, covering an area of about 7½ acres. This is divided into eight bays, each equipped with overhead travelling crane and powerful modern machinery capable of dealing with plates 40 ft. long and 1½ in. thick. Each bay is equipped for a special section of the work, the idea being to facilitate rapid production. Messrs. Harland & Wolff's entire establishment at Belfast, including the new yard, covers an area of 220 acres, and gives employment to 22,000 men.

The London Electric Wire Company & Smiths, Limited, have made an issue of 350,000 7½ per cent. cumulative preference shares of £1 at par, part of

the authorised amount of 500,000 shares. The authorised capital is £750,000, of which £644,070 has been issued and is fully paid. There are no debentures or mortgages. The company manufactures all kinds of copper and other wires, bare and insulated, for electrical purposes, and was originally established in 1859. According to the last balance-sheet the assets stood at £945,881, against which there were liabilities to creditors of £178,869, leaving a surplus of £767,012. The present issue is made for the purpose of extending the company's buildings and equipping additional shops.

THE keel for the first vessel has been laid at the new shipbuilding yard at Bideford of the Hansen Shipbuilding and Ship-Repairing Company, Limited. The work of converting the old "Donkey Yard," where wooden ships were last constructed forty or fifty years ago, into a modern site for up-to-date shipbuilding, was commenced at the end of March last, and the practical completion of the work in eight months is something of a record. The vessel, the keel plate of which has been laid, will be a single screw cargo steamer with long raised quarter deck and forecastle. The main dimensions are 190 ft. B.P. by 30 ft. by 14 ft. 6 in. moulded depth. She will be of over 1,000 tons deadweight capacity, and will be driven by triple expansion engines.

MR. R. D. MCCARTER and Mr. W. L. Cooper have entered into partnership as consulting engineers, under the name of McCarter & Cooper. Mr. McCarter, prior to 1902, was chief engineer to the General Electric Company, and from that date until 1914 he carried on a consulting practice in London. Mr. McCarter was consulting engineer to all the European Westinghouse Companies, and president and managing director of the Russian Westinghouse Company. Mr. W. L. Cooper was for 15 years resident in London as European manager and chief engineer of Messrs. R. W. Hunt & Company, inspecting engineers. Messrs Anthony Brown & Hooghwinkel, Limited, civil and electrical engineers, 24, Martin Lane, Cannon Street, London, E.C.4, have concluded a working arrangement with Messrs. McCarter & Cooper.

ON Dec. 2, Dr. J. F. Crowley presided over a meeting in London to inaugurate the winter campaign of the South-Eastern district of the Society of Technical Engineers. Mr. C. H. Wordingham, who was the chief speaker, explained that the formation of the society had been precipitated by the establishment of the Whitley Councils. These councils simply recognised two parties in an industry—employers and manual workers. Being in neither of these categories, technical engineers were left entirely out of consideration. But they felt that they wanted recognition, and the only way to obtain it was to register as a trade union—a step which they had recently taken. They really desired to uphold the dignity of the profession by influencing the course of political events, and thus promoting the best interests of the nation.

THE NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY COMPANY, LIMITED, which holds all the issued share capital of the County of Durham Electrical Power Distribution Company, Limited, Houghton-le-Spring and District Electric Lighting Company, Limited, Tees Power Station Company, Limited, and also over 99 per cent. of the issued share capital of Cleveland and Durham Electric Power, Limited, and, with its associated companies, is one of the largest producers of electrical energy in the world, supplying energy throughout an area of over 1,400 square miles in extent, have made an issue of 1,500,000 7 per cent. cumulative preference shares of £1 each at par. The profits have steadily advanced from £95,910 in 1912 to £238,043 in 1918, and the dividend on the ordinary shares has in the same time risen from 5 per cent. to 8 per cent.

IN a statement issued by Mr. D. A. Bremner, director of the British Engineers' Association, it is pointed out that during the war 18,028,000 working days were lost through strikes. This is equivalent, for example, to 250,000 workmen ceasing to produce any values and becoming a burden on the rest of the community for a period of 13 weeks. In 1918 there were 1,252 trade disputes, and an equal number have occurred during the first 10 months of 1919, corresponding, at the same rate, to 1,500 for the whole year. From January to October of this year no fewer than 30,957,000 working days were lost. Since the beginning of 1918 the net increase in the weekly wages paid has amounted to £4,178,600, corresponding to £217,287,200 per year. During the period January to October, of the current year, 5,356,000 workpeople have had their hours of work reduced, and the aggregate reduction of working hours per week amounts to 35,630,000.

SIR VINCENT CAILLARD, the retiring president of the Federation of British Industries, presided at the annual meeting in London, on November 12, and referred to the recent labour unrest and the general labour outlook for the future. "Is the strike fever now subsiding?" he asked. "The answer to that lies partly with ourselves—I mean with the employers. The question necessarily presents itself to every thinking mind, Why should not the results arrived at after a strike be reached before? The results must be reasonable, otherwise they would be useless. Why must the production of the country, which means the country itself, be made thus to suffer unnecessarily? I believe myself that, so far as we employers are concerned, we do not, as a general rule, take our employed sufficiently into our confidence, and let them know what is passing in our minds. There is no reluctance, quite the contrary, on our part that Labour should have that better place in the sun, and that greater share in the settlement of working conditions, which it claims."

IN his recent statement on the railway situation, in the House of Commons, Sir Eric Geddes said that there was not one of the belligerent countries whose railways were regaining their ordinary position with regard to traffic with less dislocation than this country. In this connection the Ministry of Transport makes the following statement, showing the precentage of wagons and locomotives under, or awaiting, repair in those European countries for which information is available. These figures show the actual position in November:—Wagons: Great Britain, 6 per cent.; Poland, 10 per cent.; Czecho-Slovakia, 12 per cent.; Greece, 14 per cent.; France, 15 per cent.; Italy, 18 per cent.; Hungary, 24 per cent.; South Russia, 25 per cent.; Austria, 35 per cent.; Roumania, 42 per cent.; Bulgaria, 44 per cent. Locomotives: Great Britain, 21 per cent.; France, 22 per cent.; Greece, 24 per cent.; Italy, 27 per cent.; Poland, 30 per cent.; Austria, 37 per cent.; Czecho-Slovakia, 38 per cent.; South Russia, 49 per cent.; Bulgaria, 63 per cent.; Roumania, 71 per cent.; Hungary, 73 per cent.

A BILL dealing with increased production has recently been drafted by Mr. A. E. Beck, a Birmingham manufacturer. The Bill will shortly be considered by the Midland Branch of the National Union of Manufacturers. Mr. Beck proposes that when a manufacturer finds his output of work less than it should be a notice shall be exposed in the department or works affected stating that the average output per man per hour "has been during the last 28 days — per cent. less than (a) it was prior to the war; (b) than it is in other works in the same trade; (c) than it is in similar works abroad"; and if, after ten days from the date of the notice (which shall include one complete pay week), the output has not improved by the percentage named the employer shall be empowered to give notice to the Board of Trade, requesting them to appoint a committee of investigation, to act in accordance with the powers which would be conferred upon them. In order to encourage a spirit of initiative and enthusiasm among the workpeople it would be open for an employé to serve upon the employer notice of any suggestion by which the output can be increased, and the committee might award such employé a sum not less than £5 nor more than £50, which would be charged upon the employer.

THE BRITISH ENGINEERING STANDARDS ASSOCIATION have issued a new specification for insulated conductors for electric light and power purposes, which differs radically in many respects from its predecessors. The basis of this is a table giving a series of 13 wires ranging in diameter from .0076 in. to .1030 in. From these wires are drawn up a table of solid and stranded conductors ranging in area from .0010 sq. in. to 1 sq. in., there being 24 sizes. The series of wires ordinarily used in making up cables embodied 25 sizes, and the conductors recognised as standard and covering the same range as the present list contained 59 sizes. The sizes in the new list are designated by their nominal area, that is, area, expressed at most by three significant figures, these nominal sizes being within a very small percentage of the actual calculated area. Corresponding to the standard ordinary conductors are two tables of flexible conductors. The first, which is for flexible cords, comprises six sizes, which are substantially those now ordinarily used. The final table is of flexible standard conductors, corresponding in area to the areas of the main table. In most cases only one degree of flexibility is provided, but in some cases a duplicate cable is given for purposes where only moderate flexibility is required.

THE GARDINER SHIPBUILDING AND ENGINEERING COMPANY, LIMITED, with a share capital of £600,000, divided into 400,000 8 per cent. cumulative participating preference shares of £1 each and 400,000 ordinary shares of 10s. each has recently been formed. The preference shares, in addition to their fixed cumulative dividends, are entitled to participate in surplus profits after the ordinary shares have received 8 per cent. to the extent of 25 per cent. of such surplus, 50 per cent. going to the ordinary shareholders and the remaining 25 per cent. to be distributed among the employés. The company takes over the shipyards and business of the Gardiner Shipbuilding and Engineering Company, including freehold properties, approximately 151 acres in extent, situated on the west side of Poole Harbour. It has a frontage to the harbour of about 1,830 feet, and it is stated that ships up to 20,000 tons displacement can be launched and taken to sea. The standard gauge internal railway connects up with the main L. & S.-W. Railway, and provides for the delivery of material throughout the yard. The company, it is stated, takes over contracts exceeding £2,000,000 for twelve steel steamers of 7,600 tons, six of which are now under construction. The 8 per cent. cumulative participating preference shares have been offered for subscription this week.

ON Saturday, December 6, the employés of Cammell, Laird & Company, Limited, at Penistone, welcomed home comrades who had served in the war, and presented cheques to them from the Works War Fund. Mr. G. A. B. Lockley, manager of the works, was in the chair, and with him were Mr. W. L. Hichens, chairman of the company, Mr. John Marsh, secretary of the fund, and members of the committee. Mr. W. L. Hichens said he would like the men to know him personally as far as it was possible, for it was the human intercourse which brought about the best feeling between employer and employé. The employer had a peculiar position, for he had to propitiate the capitalist in order to run his industry; and he had at the same time to try to keep on the best of terms with the workers. His business was to try to keep the balance between all the interests involved. But taking them altogether, employers were not so bad as they were sometimes pictured. As to the future, industrial unrest was the serious difficulty with which this country was faced. It seemed to him that in that direction there was a lack of the high ideal for which so many of our brave lads laid down their lives. Employers were too engrossed in their profits, whilst employés thought most of their wages. If our fellows were prepared to die for our country, surely we should be prepared to live for it.

THE Tyneside shipyards of Sir W. G. Armstrong, Whitworth & Company, Limited, are now carrying out one of the most extensive re-conditioning contracts ever undertaken by a shipbuilding firm. This contract is for the complete overhauling and refitting of the quadruple screw Cunarder "Aquitania" after her four years of strenuous war service. This vessel—the largest which has ever entered the Tyne—is now berthed at the fitting-out quay of the Armstrong Yard, where she will remain until completed. An important feature of the work to be carried out, as we have already noted, is the equipment of the vessel for the burning of oil fuel. A reduction of over 300 hands will become possible, and this together with the abolition of coal bunkers will greatly increase the available carrying capacity of the vessel. The s.s. "Bratton Castle," a new vessel for the Union Castle Mail Steamship Company, Limited, has been launched from the Armstrong Whitworth yards. The vessel, which is specially designed on straight lines, and is constructed on the Isherwood system, was built under the programme laid down by the Minister of Shipping during the war. She is 411 ft. 6 in. in length between perpendiculars, and has a breadth of 55 ft. 6 in. and a draft of 28 ft., the dead weight being about 10,700 tons. The engines, which are designed to give a speed of 11 knots, are of the triple-expansion type.

A RECENT issue is one of £300,000 in 6½ per cent. five-year notes at 98 per cent. in the Partington Steel and Iron Company, Limited, the notes being redeemable at 102 per cent. They are guaranteed unconditionally as to principal (including premium) and interest by the Pearson & Knowles Coal and Iron Company, Limited, and will be issued in denominations of £500, £200, and £100 only, but instalments are spread over the next five months. The company was formed in 1910, and the property, which is of freehold tenure, comprises about 192 acres of land on the Manchester Ship Canal, while the company own important works and furnaces. The share capital is £700,000, and there are issued and outstanding £167,000 in 5 per cent. first mortgage debenture stock and a second debenture and deeds of further charge issued to the Minister of Munitions to secure advances not exceeding a maximum sum of £926,000, of which £561,000 had been advanced and secured up to June 30 last. The proceeds of the present issue are to be applied for the general purposes of the company, and particularly towards the cost of certain extensions. In return for the guarantee the Pearson & Knowles Coal and Iron Company, Limited, are to receive from the company an annual premium at the rate of one-half per cent. upon the nominal amount of the notes for the time being issued and outstanding.

THE BENGAL IRON COMPANY, LIMITED, has been formed to acquire as a going concern the assets and undertaking of the Bengal Iron and Steel Company, Limited. The new company's share capital is £2,500,000, divided into 750,000,000 7½ per cent. cumulative preference shares and 1,750,000 ordinary shares of £1 each. Of the ordinary shares 1,311,750 will be issued to the vendors as fully-paid, and a further 262,350 are reserved for subscription by them at par, while an issue is being made at par of 500,000 preference shares. Subscriptions have been invited for these 500,000 preference shares or such lesser number, not being less than 350,000, as shall remain after satisfying the claims of preference shareholders in the vendor company under the purchase agreement. The land, buildings, works, railways, general plant and tools stood in the books of the old company at September 30, 1918, at £563,808, after deducting £256,392 for depreciation, renewal, and sinking funds, and taking the rupee at the average rate of about 1s. 4d. This figure does not include anything in respect of goodwill nor of the value of the iron-ore deposits. It is stated that the latter have been proved to contain a practically inexhaustible supply of very high-grade iron ore which can be profitably and cheaply worked, and it is difficult to put a limit on the potential value of this asset. The average profit of the old company for the last seven years were £120,697 per annum, or for the last four years £172,150 per annum.

PARTICULARS are issued of Sheffield Steel Products, Limited, which has a share capital of £1,000,000 in

£1 shares, all of which have been issued and are fully paid. The company consists of the following businesses, which are engaged in the manufacture of table cutlery, scissors, razors, spanners, pincers, files, etc., or as drop forgers and nickel platers: W. K. & C. Peace, Limited, Carr, Wild & Company, Limited, E. W. Cheesman & Company, Joseph Peace & Company, Limited, Boswell, Hatfield & Company, Limited, Sheffield Steel Products, Cutlery & Tool Manufacturers, Arnold & Son, Chaucer Plating Company, Sheffield Scissors, Razor, & Tool Company, Limited, and Moses Eadon & Sons, Limited. The object of the amalgamation is to put the company into a position to manufacture in bulk on a central site, and on the most economical and up-to-date basis. The company has contracted for the purchase of the National Projectile Factory, at Templeborough, Sheffield, which is one of the largest erected by the Government during the war. The company has also contracted for the purchase, with the Templeborough Factory, of the whole of the motors (capable of supplying 4,000 h.p.), shafting, pulleys, and belting installed therein, together with a large quantity of productive machinery. Work is already in progress and additional plant, which has been ordered by the company, is being installed with as little delay as possible. The directors of the company are: Mr. A. H. Wild, Mr. J. H. Stewart, Mr. R. E. Skipwith, Mr. J. T. Wood, and Mr. F. H. Cuthbertson.

A BRITISH section of the Société des Ingénieurs Civils de France has been formed, with offices at 49, Great Marlborough Street, W.1, and recently, at the Society of Arts, the inaugural meeting was held, being preceded by a social function. At the meeting, over which Mr. C. H. Wordingham, the hon. president, presided, there was a large attendance of eminent members of the profession and its allied industries. The chairman said that organisations had already been created to strengthen the Entente Cordiale between Great Britain and France in the worlds of art, commerce, education, and of politics. Engineers could not lag behind; hence the creation of this British section of the French Society of Engineers, a society which embraced all branches of engineers, civil, electrical, mechanical, mining, etc. M. Gueritte, the president, in his inaugural address, described the policy of the section, which, he said, aimed at the forming of a link between British and French engineering societies by drawing them into close contact with each other and keeping them informed of important forthcoming papers or meetings in either country; also at promoting personal and friendly intercourse between British and French engineers, and at inducing British engineers to take an active interest in the work of the French societies and French engineers who sought admission into British institutions or societies. A scheme was being set up for the exchange of engineering students and young engineers between the two countries and to secure a recognition in one country of the university degrees or diplomas conferred in the other.

ADDRESSING the shareholders of Dorman, Long & Company, Limited, at Middlesbrough, on December 16, Sir Arthur J. Dorman dealt with the company's extensions at Redcar. Sir Arthur remarked that that important undertaking was entered into at the instance of the Government in order to increase the output of steel, so vital to the prosecution of the war. The works were started in February, 1916, and were making steel ingots in February, 1917. Owing to the skill and determination of Mr. Ennis and his staff, the company were now rolling plates. A fresh chapter in the history of the company was begun last week when the new plate mill started work. So far work had progressed more smoothly than any of them dared to hope. The directors' plans also provided for the rebuilding of two of the blast furnaces at Redcar, and it was hoped one would be in blast in February or March. With the four furnaces now working, these should give sufficient metal to meet the requirements of the steel furnaces. Extensive alterations and improvements had been made to the wharf and its approach, thus providing ample accommodation and much improved facilities for shipping. Dealing with the question of housing, he said the company had continued their policy of providing housing accommodation for the workmen at Dormanstown, and a new system of construction had been invented by Mr. Ennis, by which houses were constructed with a steel frame. The system had been approved by the Ministry of Health, and sanctioned for use in all State-aided housing schemes. An organisation was being formed, in co-operation with building contractors, which it was hoped would allow for the building of this type of house in large numbers throughout the country. The houses could be built in most localities to compete successfully with brick-built houses in price, speed in building, durability, and comfort. The chairman then went on to deal with the North-Eastern Steel Works, which, he said, early in the year it was decided to close down and take advantage of the stoppage to alter the process of manufacture from basic Bessemer to basic open-hearth steel. That alteration was now being carried out.

THE tenth annual dinner of the Manchester and District Iron, Steel and Allied Trades Bowling Club was held on Saturday, December 6, at the Victoria Hotel, Manchester. Mr. J. E. Kidd (president) occupied the chair, and the company included Messrs. C. E. Rigby (John Rigby & Son, Limited), Mark Oliver (Oliver & Unsworth), W. H. Calder (Secretary of the British Federation of Iron, Steel, Metal and Tinplate Merchants), E. H. Bennett (J. J. Bennett & Son), J. W. Thompson (J. J. Thompson & Son), J. S. Webb (J. Webb & Sons, Limited), J. Hart (Thompson & Company, Wigan), H. Blackburn (Harrison, McGregor & Company, Limited), C. P. Kidd and E. Norris (John Kidd & Sons, Limited), J. B. Lees (George Bradshaw & Company, Limited), A. E. Upton (Vickers, Limited), C. Perrot (J. F. Melling and Company, Limited), H. C. D. Scott (Royles, Limited, Irlam), A. T. Cussons, R. Dean, F. Lucius, F. F. Page, W. F. Spencer, J. R. Ashton, J. W. Schofield, W. P. Pearson, E. L. Barritt, H. Grime, R. Heath, E. Edwards, A. H. Kay, R. Hailwood, A. McMirdo, J. Waring, J. J. Bennett (J. J. Bennett & Son), E. H. C. Roberts, G. Dale, W. Gilmore, W. E. Astley, G. W. Thornton, E. Holt, F. Shepherd, A. Fleet (North Staffordshire Railway), H. Alcock, J. Dale, E. A. Herbert, E. Pearce (Messrs. Pearce & Company), — Thornton, jun., J. G. Gilmour, John McCoy, Colonel Bentley (J. Bentley & Company, Limited), Captain Maiden (National Radiator Company, Limited), Lieut. Rigby (John Rigby & Sons, Limited), Lieut. Paterson (Howell & Company, Limited), and Dr. F. da Cunha. The guest of the evening was to have been Major Nall, D.S.O., M.P., but, owing to illness, that gallant officer was unable to be present. The feature of the evening was the presentation to Mr. "Jack" Thompson of a handsome silver loving cup, bearing the following inscription:—"Presented to J. W. Thompson, Esq., by the members of the Manchester and District Iron, Steel, and Allied Trades' Bowling Club as a token of their esteem and acknowledgment of his valuable services as honorary secretary and treasurer, 1915-1919." This was accompanied by a suitable gift for Mrs. Thompson. In making the presentation, the chairman highly eulogised Mr. Thompson's services to the club, and mentioned that 90 per cent. of the members had subscribed towards the testimonial. Mr. J. W. Thompson, in acknowledging the gifts, enlarged upon the value of the club as a means of establishing good fellowship between members and of promoting a better understanding between manufacturer and consumer. He attributed the success of the club largely to the efforts of his predecessor in office (Mr. J. B. Lees). Mr. C. E. Rigby was installed as president for 1919-20, and the various speeches included one by Mr. W. B. Calder, who, speaking as a Scotsman, admitted that there was not a single city in the Kingdom which possessed so much character and business acumen as Manchester.

Personal.

THE late Mr. R. S. Hellyer, lead merchant, of Red Lion Square, E.C., left £17,658.

JUDGE E. H. GARY, chairman of the United States Steel Corporation, celebrated his seventy-third birthday recently.

MR. F. J. BENSON has joined the board of Richardson, Duck & Company, Limited, shipbuilders, of Thornaby-on-Tees.

MR. G. CHEESMAN, who established the National Union of Manufacturers, has been the recipient of a handsome presentation from the members.

THE late Mr. J. Inglis, engineer and shipbuilder, of A. & J. Inglis, Limited, of Glasgow, left personal estate in the United Kingdom valued at £387,530.

MR. P. H. PRICE, who was head of the secretarial department, has been appointed secretary to the Railway Clearing House in succession to the late Mr. H. C. Smart.

MR. E. T. ATKINSON, K.C., has been appointed a Commissioner under the Railway and Canal Traffic Act, in place of the late Hon. Alfred Erskine Gathorne Hardy.

MR. M. J. BUTLER, managing director of Armstrong, Whitworth & Company, of Canada, has resigned. He was formerly general manager of the Dominion Steel Corporation.

MR. A. L. MCCOLL has been elected a director of the Vacuum Oil Company, Limited. He was for many years employed in the Locomotive Department of the Glasgow and South-Western Railway.

DR. C. H. DESCH, of the Royal Technical College, Glasgow, has been appointed Professor of Metallurgy at Sheffield University in succession to Dr. Arnold, who recently resigned and has been elected Emeritis Professor.

MR. G. H. LEE, formerly with the Tata Iron & Steel Company, Sakchi, India, and lately in the London office of the Consolidated Steel Corporation, New York, has been appointed sales manager for the latter company at Calcutta.

CAPTAIN R. H. MONTGOMERY, of the fuel department of the Automobile Association, and secretary of the Joint Fuels Committee, has been appointed to represent the Association on the Petrol Profiteering Committee.

MR. T. FENDER has been elected a director of the Naval construction works on Barrow Island of Vickers, Limited. Mr. Fender for some time has been works superintendent at the Barrow shipyard, joining Messrs. Vickers eighteen years ago.

THE late Mr. P. Williams, general manager of the Normanby Park Steel Works, of John Lysaght, Limited, of Bristol, and a director of the Brymbo Steel Company, Limited, left estate of the gross value of £80,057, with net personalty £69,808.

MR. H. O. KING has been appointed London secretary *pro tem.* of the Ropner Shipbuilding and Repairing Company (Stockton), Limited, with offices at 9, New Broad Street, E.C.2, to deal with matters connected with preference and ordinary share transfers and certificates.

MR. F. L. LANE, managing director of the Leeds Forge Company, Limited, has severed his connection with that company to become advisory director to Clayton & Shuttleworth, Limited, of Lincoln, who, as we have already noted, have converted their Abbey Works, Lincoln, for the construction of railway carriages and wagons.

ON the occasion of his leaving the works of Babcock & Wilcox, Limited, Dumbarton, to take up a position with the same firm in Spain, Mr. G. F. Ross, manager of the tube mills, was entertained by the employés at a complimentary dinner. Mr. L. Short, general manager of the Dumbarton works, presided, and during the evening a handsome presentation was made to Mr. Ross.

MR. F. DEAN has decided to retire from the works managership of R. Hood, Haggie & Son, Limited, to reside in the South of England. The directors have made a new agreement with Mr. Dean to serve the company in London and the South, and he will still remain a director on the board. The directors have appointed Mr. E. B. Frail (who has been in the company's employ for many years) as superintendent of the works in succession to Mr. Dean.

MR. J. E. MILLER, the younger son of Mr. T. Miller, J.P., manager and a director of J. Rogerson & Company, Limited, Wolsingham Steelworks, Co. Durham, at the recent prize distribution at Darlington Technical College was the recipient of three medals. These were the City and Guilds of London Institute Bronze Medal (1918) and Silver Medal (1919) for iron and steel manufacture, and the College Bronze Medal for Chemistry (1919). Mr. Miller was coached by Mr. J. L. Bentley, chief chemist for the Darlington Forge Company, Limited.

THE council of the Iron and Steel Institute have nominated Dr. J. E. Stead, F.R.S., as president of the Institute, in succession to Mr. Eugene Schneider. Dr. Stead first became a member of the council in 1895. He was elected vice-president in 1910, and for some time has been the senior vice-president of the Institute. The council are to be congratulated on having at length overcome Dr. Stead's reluctancy to accept the office of president, for which his position as the leading metallurgist in this country long ago marked him out.

SIR ALLAN M. SMITH, who has been elected Member of Parliament for the South Croydon Division, served for a time in the office of Messrs. Biggart, Lumsden & Company, writers, Glasgow, ultimately becoming a partner in the firm. When the Engineering Employers' Federation found it necessary to remove their headquarters to London, Mr. Smith, as he then was, was appointed secretary. Later he was appointed permanent acting chairman of the Federation, and during the war he served on many special committees appointed by the Government.

Applications for Patents.

Bennett, A. E. Turret heads for machine tools. 27,878. November 11.

Bigot, A. Tunnel furnaces. 28,071. November 12. (France, September 6.)

Broadley, J. R. Machines for grinding ores, minerals, stones, etc. 28,209. November 14.

Coles, S. O. Cowper-. Process for making tin boxes or cases. 28,166. November 13.

Hamer, W. Dampers for furnaces, flues, etc. 28,363. November 15.

Jacobs, C. F. Welding metal objects. 28,017. November 12.

Jones, A. H. Ore-separating devices. 27,951. November 11.

Jouve, F. L. Wire-drawing machines. 28,312. November 14.

Leeds Forge Company and Davidson, G. F. Manufacture of flanged metal plates, bars, etc. 27,814. November 10.

Marks, E. C. R. (*American Steel Foundries.*) Transitional coupler mechanism. 27,917. November 11.

Pickard, E. Furnaces. 28,229. November 14.

Smith, J. W. Engineers' gauges. 27,836. November 11.

Parliamentary Notes.

Expenditure on Munitions of War.

MR. J. HOPE writes in reply to Mr. Swan, that the expenditure during the current financial year on the purchase and production of munitions of war on contracts and orders placed since the armistice, has been approximately £5,000,000, and the present monthly rate of expenditure on these contracts and orders is about £500,000. Owing to the existence of large supplies of munitions on pre-armistice contracts and orders, these figures are much larger than those which would obtain under normal peace conditions.

Electricity Supply Bill.

On the motion for going into Committee on the above Bill, the LORD CHANCELLOR recently made a general statement in explanation of amendments which stood in his name upon the order paper. It was proposed under the arrangement that only one distinguishable portion of the Bill would be proceeded with by their lordships in the present Session. The amendments which he had put upon the paper as a result of the consultations that had taken place could be briefly described. They cut out of the Bill, first, all the compulsory powers for the establishment of district electricity boards; secondly, all the compulsory powers for the acquisition of main generating stations or main transmission lines; thirdly, they cut out the financial clauses of the Bill, excepting Clause 19, which provided for emergency power stations. The Bill would now provide for the establishment of electricity commissioners, which would exercise the present powers and duties of the Board of Trade under the Electrical Lighting Act, and the orders and regulations made thereunder, and the power to conduct experiments provided in Clause 3, and also the power to set up an advisory committee under Clause 4 of the Bill. All the compulsory powers of the Bill were to disappear for the moment.

The House then went into Committee, and all the amendments standing in the Lord Chancellor's name were agreed to *en bloc*, and the Bill was reported to the House.

Manufacture of Ferro-Alloys.

SIR A. GEDDES recently stated that ferro-tungsten and tungsen powder had been placed in the schedule of products of unstable key industries, of which the importation was prohibited because of their importance in the manufacture of high-speed steel, and the fact that before the war the United Kingdom was entirely dependent for the supply of those products upon Germany. It was difficult to compare the relative values of various alloys with differing applications, and though the importance of ferro-chrome was, he thought, fully recognised, the Government felt that the case for its special treatment was less strong than that of the substances and articles whose importation they had restricted. The difficulties in which British manufacturers were placed were mainly due to the existence of large stocks in this country.

New Housing Bill.

The new Housing Bill, introduced by Dr. Addison, consists of twelve clauses, which embody various proposals for facilitating the provision of houses already announced by the Minister. In particular, it provides for the payment of the subsidy of £150 per house completed within a certain period, and for the issue by local authorities of local bonds, as recommended by the Treasury Committee. The main proposals are as follows:—1. To make grants to persons or bodies constructing houses for the working classes, the aggregate amount of such grants not to exceed £15.000.000. 2. To meet expenses incurred in converting houses into flats. 3. To prohibit building operations which interfere with the provision of dwelling houses. 4. To prohibit, under a penalty the demolition of any house reasonably fit, or capable of being made fit, for habitation. 5. To empower local authorities to raise money by the issue of local bonds. 6. To enable local authorities to acquire land for garden cities or town-planning schemes.

Welsh Plate and Sheet Trade.

SIR R. WILLIAMS informed Mr. W. Thorne that he had no reason to believe that the Welsh plate and sheet trade was suffering undue disadvantage in comparison with other trades in consequence of the shortage of wagons. That trade had the benefit of coastwise facilities, and it was suggested that the utmost use should be made of that means of transport.

Export Credits.

In reply to a question by MR. A. HENDERSON, the President of the Board of Trade said that the export credit scheme only came into force on September 8, and no money had as yet been actually disbursed, but applications for advances to be taken within a specified date had been sanctioned up to a total of about £69,000. Tentative applications also approved, together with other proposals under consideration, represented an additional £978,000. The classes of goods in respect of which applications had already been sanctioned included iron and steel goods, hardware, rope, tinplate, etc. The amounts sanctioned varied from quite small sums up to £45,000. Of the advances sanctioned, £3,771 1s. 11d. was in respect of exports to Finland; £15,394 to Czecho-Slovakia; and £50,000 to the area to which the scheme applied in Russia.

Purchase of Locomotives.

Prior to the establishment of the pool from which locomotives were allocated to railway companies under the direction of the Ministry of Transport, fifty new locomotives were sold to British railway companies for £515,000, MR. KELLAWAY informed LIEUT.-COL. CLAY on November 27. No locomotives had been sold under the directions of the Ministry of Transport.

Railway Material at Richborough.

Replying to MR. HOHLER, on Dec. 1, Mr. Forster said:—The number of locomotives from overseas on hand at Richborough, on September 1, was 118. One hundred and three have since been removed, leaving 15, which arrived on various dates between July 10 and August 24. The number of railway trucks lying at Richborough, on September 1, was 307, all being 20-ton box vans intended for use in France and out of gauge for British railways. As they are not required by the War Department overseas they have remained at Richborough. These trucks have been handed over to the Disposal Board.

Finance of Ministry of Munitions.

The actual debit balance of the Ministry of Munitions, on September 30, was £72,800,000, MR. HOPE recently stated. This figure did not take into consideration a sum of about £30,000,000 due to the Ministry for supplies already sold, but not paid for, and for disposals on the part of other Government Departments, which had not yet been credited to the Ministry of Munitions. Taking current and anticipated receipts from disposals into account, he was satisfied that there would be a substantial balance to the credit of the Ministry at the end of the financial year.

Vickers and Brown, Boveri & Company.

MR. LUNN recently asked the President of the Board of Trade whether Vickers, Limited, had recently acquired an interest in the Swiss electrical engineering firm of Brown, Boveri & Company; whether, under the terms of the arrangement, Brown, Boveri & Company undertook to do no business within the British Empire; whether Brown, Boveri & Company recently tendered for an electrical contract with the Edinburgh Corporation at a figure £70,000 below that of any of the competing British companies; and whether he proposed to take any action to prevent such agreements in restraint of competitive trade.

MOULDING MACHINES

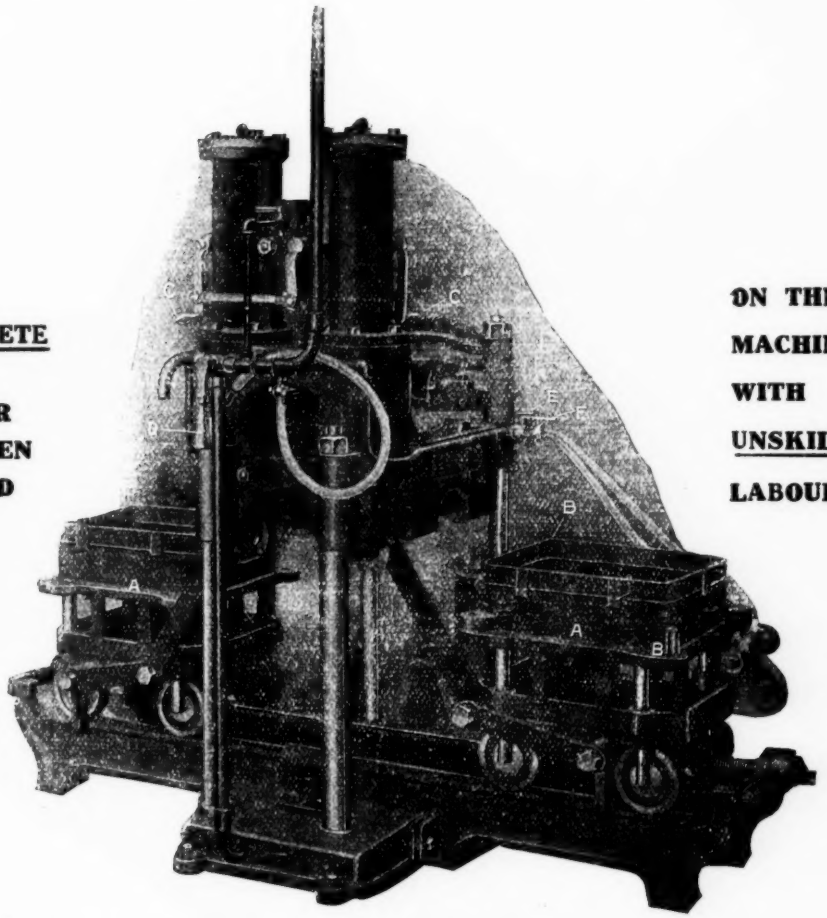
OF EVERY DESCRIPTION.

Pneumatic, Hydraulic, Jar Ramming, & Hand Power.

Type "A" Duplex Machine for Pneumatic Power.

Fitted with self-adjusting Rammer Head which accommodates itself to any varying depth of pattern.

OVER 50 COMPLETE MOULDS PER HOUR HAVE BEEN PRODUCED



ON THIS MACHINE WITH UNSKILLED LABOUR.

One of many that we have installed in various Munition Work Centres.

JAMES EVANS & CO., BRITANNIA WORKS, BLACKFRIARS, MANCHESTER.

MR. BRIDGEMAN: I understand that the fact is as stated in the first part of the question, but I have no information as to the details of the arrangement. I am aware that Messrs. Brown, Boveri & Company's recent tender for an electrical contract placed by the Edinburgh Corporation was much below the tenders of British concerns, but I understand that the difference was not so great as stated in the question. I am not clear that the last part of the question arises in this case.

National Shipyards.

COLONEL LESLIE WILSON, in a recent reply to MR. DONALD, said that there were two berths completed with launching ways and two berths completed without launching ways at Beachley, and four berths completed at Chepstow. Two berths were partly completed at Beachley, and two partly completed at Chepstow. Four keels were laid down at Chepstow and three in Finch's Yard. There was sufficient material and plant to equip Chepstow and Beachley as self contained yards. Ships' material was still coming in, and a small amount of shipyard machinery. Eight cantilever cranes were completed, and five were partly erected. Two hundred and nine cottages were completed, and 253 were in course of erection.

Sale of Government Ships.

Replying to a question by Mr. V. Hartshorn, the Ministry of Shipping), stated that forty ships of 343,788 tons deadweight were sold at £25 per ton, less depreciation at 7 per cent. per annum, to Lord Inchcape for distribution. In addition, the contracts for 156 ships under construction—of about one million tons deadweight when completed—were transferred, the instalments paid to the builders being refunded. The number of standard ships contracted for by the Shipping Controller were 682, of approximately three million gross tonnage. In addition, a large quantity of tonnage was contracted for abroad. Practically the whole of these have now been disposed of.

Deaths.

THE death took place in Paris recently of M. Marc Raty, the vice-president of the Comptoir Metallurgique de Longwy.

THE death took place at Stanford, Whiting Bay, Arran, on December 6, of Mr. R. Smith, ironfounder, of Messrs. Smith & Hamilton, Airdrie.

THE death took place at his residence, Glyn Leirios, Neath, on December 6, of Mr. H. S. Sutton, the principal of the firm of Messrs. T. S. Sutton & Sons, metal refiners, Neath.

THE death took place in New York of Mr. H. C. Frick, the well-known American steel magnate, in his 70th year. The deceased gentleman embarked in the coke business early in life, and ultimately became president of the Frick Coke Company, one of the largest coke-producing concerns in the world. Mr. Frick was also associated with the late Mr. Carnegie, and had been chairman of the board of managers of the Carnegie Steel Company.

THE death recently occurred suddenly of Mr. E. Wardle, a director of Manning, Wardle & Company, Limited, of the Boyne Engine Works, Hunslet, Leeds. The deceased gentleman combined the interests of commercial life with country pursuits. At the time that the firm of Manning, Wardle & Company (of which his father, the late Mr. Charles Wardle, was one of the founders) was converted into a limited company, he was the sole proprietor, and he became a director, taking an active interest in the business up to the last; in fact, he was at the works up to the evening of the day on which he died.

MR. J. H. WICKSTEED died at his residence in Westwood Lane, Leeds, on Tuesday, December 16. The deceased gentleman was apprenticed to the tool-making business of Messrs. Joshua Buckton & Company, of the Well House Foundry, Leeds. In time he became the firm's chief designer and representative, and was ultimately taken into the partnership, becoming head of the concern many years ago, on the death of Mr. Joshua Buckton and Mr. George Buckton. He was president of the Institution of Mechanical Engineers in 1903. Mr. Wicksteed was the inventor of many mechanical appliances that have been of great service in engineering, chief among them being his vertical single lever testing-machine and his horizontal universal testing-machine. He was also directly identified with such inventions as multiple drills, two-spindle radial drills, double-cutting tool-holders for planing and slotting machines, hot bloom shears, hydraulic plate shears, tilting and traversing machine for rolling mills, an hydraulic traverse for testing machine poise with automatic control, an autographic test recorder, and a new form of lock-nut.

SIR JOHN JACKSON, the well-known engineer and contractor, died suddenly at Godalming on December 14. Sir John, who was on a visit to friends, was taken ill in the afternoon, and passed away a few hours later without regaining consciousness. Sir John Jackson, ex-M.P. for Devonport, was 68 years of age. Born and educated at York, he served his apprenticeship in Newcastle with a view to becoming a civil engineer, continuing his studies at Edinburgh University under Dr. Tait. When only twenty-four years of age he began business on his own account, and in the next year secured his first large contract, the completion of the Stobcross Docks at Glasgow. Following upon the Glasgow contract came the extension of the Middlesbrough, Hartlepool, and North Sunderland Docks in quick succession, the extension seawards of the fort at the end of the Admiralty Pier at Dover, and later on the completion in two-thirds of the contract time of the last eight miles of the Manchester Ship Canal. But one of the greatest works undertaken by Sir John's firm was the extension of the Admiralty Docks at Keyham, Devonport. Several important contracts were also placed with his firm by foreign Governments. Just before the war the firm was engaged upon the Mesopotamian irrigation scheme for the Turkish Government, and had already completed the great barrage across the Euphrates at Hindieh, near Babylon.

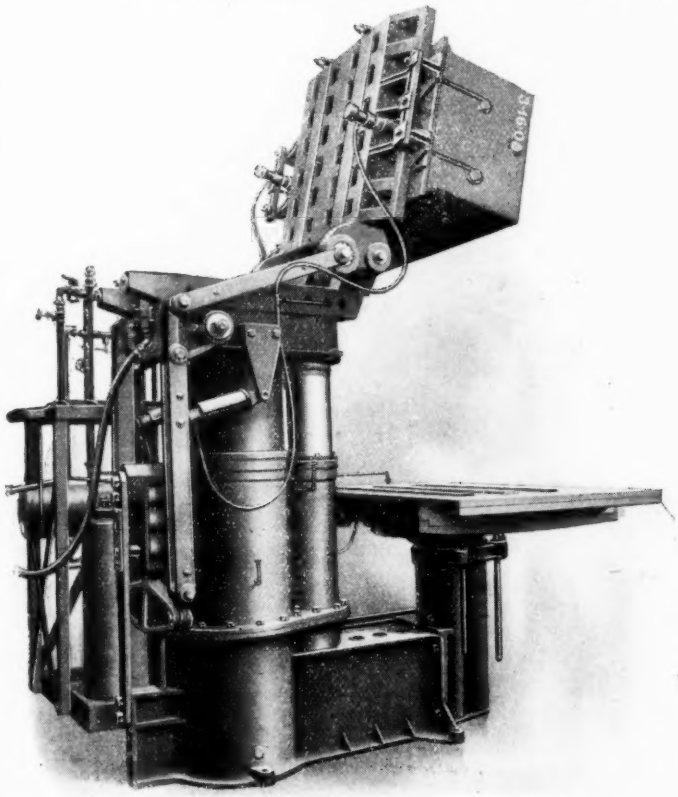
MR. J. M. WHILE died on Sunday, December 14, at Leamington. The deceased gentleman had been in failing health for several years, and was recently advised to reside in Leamington, as likely to be beneficial to his health, but a few weeks ago he had to take to his bed, and since that time his condition gradually became worse. Mr. J. M. While, M.Inst.C.E., was the second son of the late Mr. Chas. While, manager of the Treforest Iron Works. He was born in 1850, and served his apprenticeship at the works of Messrs. Fothergill & Hankey, and John Brown & Company, Limited, Sheffield. At the age of 24 he was appointed manager of the Gorton Works, Manchester, of Bolckow, Vaughan & Company, Limited, afterwards going to Brown, Bayley & Dixon, Limited, Sheffield. He spent three years with the Dowlais Iron Company, now Guest, Keen & Nettlefolds, Ltd., and in 1881 he accepted the position of general manager to the Darlington Iron and Steel Company, Limited, which post he resigned in 1891 to become general manager of the Barrow Hematite Steel Company, Limited. In 1908 he was elected a director of the latter company. At the end of 1909 he relinquished the position of general manager, but retained his directorship until 1916. The deceased gentleman was the inventor of the present method of rolling tram rails, and was the first to employ mechanical means to remove rails, bars, etc., from the hot saw to the cooling banks in rolling mills. He was for many years a member of the Council of the Iron and Steel Institute.

MACNAB & CO.

TABOR PATENTS.

Patent Combination Shockless Jar Ramming Power Roll-over and Pattern Drawing Moulding Machine.

Suitable for the most economical production of any repetition work from the smallest up to a load of 12,000 lbs. at 100 lbs. air pressure, covered by a range of five machines.



Mould having been rammed, box and pattern in act of being rolled over on to levelling table on other side of machine.

Jar rams the box in less than one minute.

Rolls the mould over, draws and raps the pattern.

Rolls the pattern back ready for the next box.

COMPLETE MECHANICAL OPERATIONS OF THE MACHINE NOT EXCEEDING FOUR MINUTES.

56/8, Eagle Street, Southampton Row, London, W.C.1.

New Companies.

Sheffield & Colonial Metals, Limited.—Capital £10,000 in £1 shares.

Birchley Rolling Mills, Limited.—Capital £50,000 in £1 shares.

Newman Brothers, Limited, engineers. — Capital £5,000 in £10 shares.

Smallpeice, Limited.—Capital £10,000 in £1 shares (5,000 Pref.), to carry on the business of engineers.

Anglo-Scottish Engineers, Limited.—Capital £15,000 in £1 shares. Registered office: 166, High Street, Stratford.

Precision Castings, Limited.—Capital £3,000 in £1 shares. Registered office: Lincoln Street, Wolverhampton.

Hartley's Malleable Fittings Company, Limited.—Capital £2,000. First director: F. Hartley. Registered office: Halifax.

Steel (Sheffield), Limited. — Capital £5,000 in £1 shares. Registered office:—Princess Works, Rockingham Street, Sheffield.

Hulme Engineering Company (Manchester), Limited.—Capital £10,000 in £1 shares. Registered office: 22, Bangor Street, Hulme.

Sandon Motor & Engineering Company, Limited. — Capital £10,000 in £1 shares. Registered offices: 1-3, Grundy Street, Liverpool.

Hulme Engineering Company (London), Limited. — Capital £10,000 in £1 shares. Registered office: Lacland Place, Chelsea, London.

Wallis & Watson, Limited.—Capital £10,000 in £1 shares, to carry on the business of engineers. Registered office: Park Row, Leeds.

F. W. Southern & Company, Limited.—Capital £5,000 in £1 shares (1,000 Pref.). Registered office:—Kirklees Wireworks, Brighouse.

Ager & Hayward Engineering Company, Limited.—Capital £10,000 in £1 shares. Registered office: 125, Edmund Street, Birmingham.

Reliance Steel Works, Limited.—Capital £10,000 in £1 shares. Registered office: Eureka Works, Cross Street North, Wolverhampton.

Dunston Engine Works Company, Limited.—Capital £25,000 in £1 shares. Registered office: Dunston Engine Works, Dunston-on-Tyne.

Taylor File and Tool Company, Limited.—Capital £50,000 in £1 shares. First directors: G. Taylor and R. Darvall. Secretary: H. B. Schofield.

Electrical Specialities Company, Limited. — Capital £3,000 in £1 shares (1,000 preference). Registered office: 33, King Chambers, Angel Street, Sheffield.

Birchley Rolling Mills, Limited.—Capital £50,000 in £1 shares. First directors: A. R. Banks, W. T. Hales, C. T. Barlow, J. Baker, and F. J. Hall.

Vowles Brothers, Limited.—Capital £15,000 in £1 shares, to carry on the business of ironfounders. Registered office: Hall End Foundry, West Bromwich.

Star Electrical Accessories, Limited.—Capital £10,000 in £1 shares (5,000 7½ per cent. cumulative preference). Registered office: 13, Frederick Street, Birmingham.

Ritchie Bros., Limited.—Capital £5,000 in £1 shares to carry on the business of tool makers. Registered office:—St. Loy's Works, St. Loy's Road, Tottenham.

Steel Breaking & Dismantling Company, Limited. — Capital £25,000. Subscribers: H. O. Edwards, F. Snowden, and B. D. Grayson. Registered office: Sheffield.

South Wales and Lincolnshire Steel Products, Limited.—Capital £10,000 in £1 shares. First directors: F. T. Thomas, H. C. Bond, H. B. Prior, and W. K. Steel.

Buck & Abbott, Limited.—Capital £15,000 in £1 shares, to carry on the business of clog-iron manufacturers. Registered office: Falcon Works, Singleton Row, Preston.

F. W. Cook & Company (Southampton), Limited.—Capital £10,000 in £1 shares, to carry on the business of engineers. Registered office: 23-4, Bargate Street, Southampton.

George McGhee & Company, Limited. — Capital £2,000 in £1 shares, to acquire the existing business of engineers, etc. Registered office: 30, Easterhill Street, Tollcross, Glasgow.

Henry J. Pratt & Company, Limited.—Capital £12,000 in £1 shares, to carry on the business of art metal manufacturers, etc. Registered office: 7, Dean Street, Birmingham.

Niagara Foundry Company, Limited.—Capital £1,000 in £1 shares, to acquire the business carried on by T. Ventom & Son, at Bank Street, Bradley, Bilston, as the Niagara Foundry.

Bowman Radiators, Limited.—Capital £6,000 in £1 shares, to take over the business of E. J. Bowman, 56, Pritchett Street, Aston Road, Birmingham, trading as the Bowman Radiator Company.

Clyde Alloy Steel Company, Limited. — Capital £60,000 in £1 shares. First directors: G. P. West and A. McCance. Registered office: Craigneuk Works, South Dalzell Road, Motherwell.

Fox Fittings Company, Limited.—Capital £2,000 in £1 shares, to carry on the business of manufacturers of gas fittings and fixtures, etc. Registered office: 102, Church Road, Erdington, Birmingham.

Croll, Hannaford & Company, Limited.—Capital £7,000 in £1 shares (5,000 8 per cent. non-cumulative preference), to carry on the business of engineers. Registered office: Snakes Lane, Woodford.

Electrical & Engineering Development, Limited. — Capital £10,000 in 9,500 eight per cent. cumulative preference shares of £1, and 10,000 founders' of 1s. Registered office: 35, Copthall Avenue, E.C.

L. and N. Engineering Company, Limited.—Capital £2,000 in £1 shares, to take over the connection of the Ingate Engineering Company, Limited. Registered office: Ingate Place, Queen's Road, Battersea.

William Mills (Sunderland), Limited.—Capital £20,000 in £1 shares, to carry on the business of mechanical engineers, etc. First directors: W. Mills, J. H. G. Mills and C. E. Rose. Registered office: 192, Bridge Street West, Birmingham.

Northern Ball Bearings, Limited.—Capital £200,000 in £1 shares. First directors: N. O. J. L. Wallenius, L. E. Little, A. Senior, L. H. Coatalen, A. G. Scammell, J. L. Tainton, and J. Beswick. Registered office:—115, Great Portland Street, London, W.

J. H. Bramwell & Company, Limited.—Capital £10,000 in £1 shares, to take over the business of a file, rasp, etc., manufacture, carried on by F. A. Bramwell as J. H. Bramwell & Company, at Garden Street File Works, 55, Garden Street, Sheffield.

Dowding & Mills, Limited.—Capital £3,000 in £1 shares, to take over the business of manufacturing electrical and mechanical engineers carried on by W. H. P. Dowding, H. L. Mills and R. Lowe, as Dowding & Mills, at 193, Camp Hill, Bordesley, Birmingham.

J. A. Kinnaird & Company, Limited. — Capital £25,000 divided into 10,000 7 per cent. preference, 14,900 preferred ordinary, and 100 deferred shares of £1 each, to acquire the business in Greenock of electrical and mechanical engineers. Registered office: 10, Blythswood Square, Glasgow.

Clarendon Manufacturing & Engineering Company, Limited.—Capital £5,000 in 3,000 preference shares of £1 each, and 40,000 ordinary shares of 1s. each, to carry on the business of de-tinners, de-galvanisers, etc. First directors: M. L. Jones, F. G. Moore, P. C. Hollingsworth, and Major O. T. Frith.

Bengal Iron Company, Limited.—Capital £2,500,000 in £1 shares, to enter into an agreement with the Bengal Iron and Steel Company (incorporated in 1889). First directors: W. T. McLellan, Sir Edwin Grant-Burls, A. Izatt, T. Jones, H. Steel, and H. Guedalla. Registered office: 17, Victoria Street, S.W.

W. H. Silvester, Limited.—Capital £10,000 in £1 shares (2,500 preference), to take over the business of an engineer and smith carried on by W. H. Silvester, at 63, Penistone Road, Sheffield, as W. H. Silvester. W. H. Silvester is permanent managing director. Registered office: 63, Penistone Road, Sheffield.

Telegrams: "Durrans, Pennistone." Telephone: 21, Pennistone.

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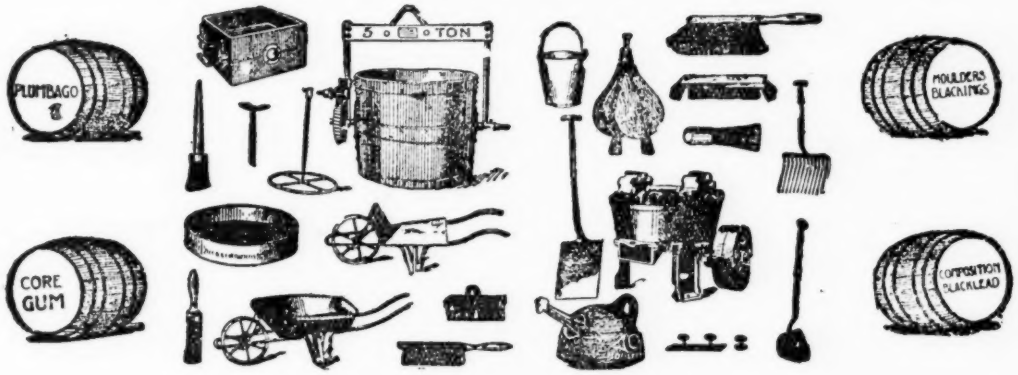
JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.



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FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

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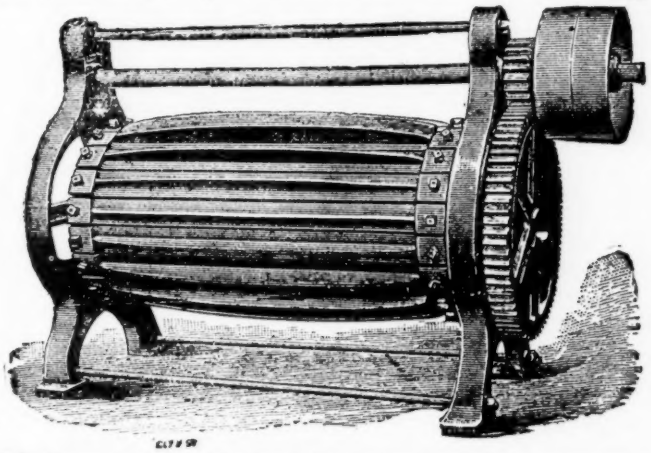

These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

Newgate Foundry, Limited.—Capital £8,000 in £1 shares, to take over the business of general engineers carried on by W. Down, A. Down, and F. Down, at Newgate, Barnard Castle, as Henry Down & Sons. First directors: W. Down, A. Down, F. Down, and E. Down. Registered office: 26, Newgate, Barnard Castle.

Clock Tower Engineering Company, Limited.—Capital £50,000 in 40,000 7½ per cent. cumulative preference shares of £1 each and 40,000 ordinary shares of 5s. each. First directors: W. J. Payne, Sarah P. Kennedy, and C. H. Parker. Secretary: G. F. Joseph. Registered office: 118, Victoria Street, Westminster, S.W.

William Gallimore & Sons, Limited.—Capital £100,000 in £1 shares, to carry on the business of manufacturers, merchants, and rollers of non-ferrous metals, etc. First directors: Sir Albert E. Bingham, Bart., G. E. Slater, J. H. Allen, and T. J. W. Allen. Secretary: G. R. Slater. Registered office: 15, Arundel Street, Sheffield.

Kartret Engineering Company, Limited.—Capital £25,000 (24,000 £1 7 per cent. cumulative preference and 10,000 2s. ordinary), to take over the business carried on by V. G. Middleton at 7, Carteret Street, S.W., as the Kartret Engineering Company. Registered office: 7, Carteret Street, Broadway, Westminster, S.W.1.

Cochrane, Morgan & Company, Limited.—Capital £20,000 in £1 shares, to adopt an agreement between Allen, Adams & Company, Limited, Southampton, and Cochrane Bros., Limited, engineers, Seaview Works, Bo'ness, and to carry on the business of shipbuilders, etc. Registered office: 199, Woodville Street, Govan, Glasgow

Fox Brothers (Swansea), Limited.—Capital £1,500 in £1 shares, to carry on the business of motor, mechanical, electrical and general engineers, etc. First directors: T. Tyrrell, G. R. Griffiths, C. W. Fox, C. W. Clement, W. H. Fox and G. W. Fox. Secretary: C. W. Clement. Registered office: Burrows Place, South Dock, Swansea.

Torrance & Sons, Limited.—Capital £50,000 in £1 shares, to carry on the business formerly carried on by Torrance & Sons, Limited (in liquidation), at Bitton, Glos., ironfounders, engineers, etc. First directors: J. R. Torrance (managing director), W. Pitt, Sir Percy K. Stothert, William Pitt, T. R. Gill, H. C. B. Sainsbury, E. S. Franklin, H. J. Thomas, T. H. Box, and C. P. Hailey. Secretary: T. D. Gill.

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Pressed Steel
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LADLES
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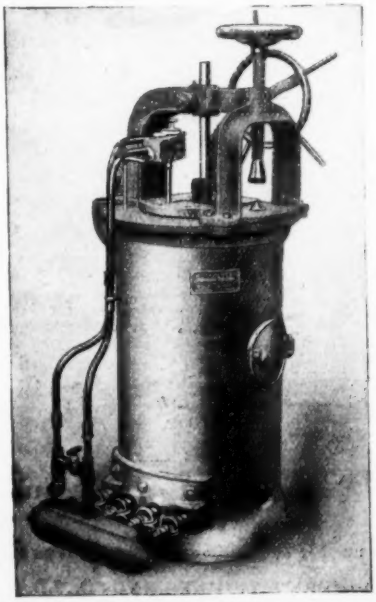

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Magneto Parts, Ball Bearing Parts, Die-Cast with Steel Balls in complete. Bearings, Screw Threads, Gears, Accumulators, Grids, Wheels, Rings, etc., etc.

The only heat controlled die-casting plant on the world's market.

Pressure of 7 tons obtained.

Complete castings up to 40-lbs. white-metal alloys can be made in one operation.

Interchangeable nozzles for different sizes of castings.

Interchangeable pots.

For the production of "dead-size die castings" in tin, lead, zinc and aluminium alloys and all white metals.

SOLE MAKERS.

MONOMETER MANUFACTURING Co.

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WE SUPPLY **THE** LEADING FIRMS IN THE TRADE WITH

FOUNDRY BLACKINGS

OF ALL KINDS

COAL DUST, CHARCOAL, PLUMBAGO and BLACK-LEAD CORE GUMS and all Foundry Requisites, and have done so since 1831.

I. & I. WALKER, EFFINGHAM MILLS, ROTHERHAM.

Our Specialite is Studying Special Requirements.
KINDLY HAND US YOUR ENQUIRIES.

The Mastery

of the Air.

TRADE SIROCCO MARK

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SEND US YOUR ENQUIRIES FOR

are always successful in the struggle for the Mastery of the Air

Ventilation of Ships, Buildings and Mines, Induced Draught on Boilers, Dust Removal, High Pressure Fans for Forge Fires and Cupolas, Air Washers for Cooling and Purifying the Air, Fans for Removing Fumes or Steam, Steam Heater Units for Heating Factories and Workshops.

Davidson & Co., Limited, *Sirocco Works,* BELFAST.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,

FIRE CLAY.

Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.

STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.,

DEEPCAR nr. SHEFFIELD.

Telegrams: "LOWOOD, DEEPCAR."

MONTHLY PRICE LIST.

The undermentioned prices, unless otherwise specified, are those obtaining at the commencement of the current month.

Pig-Iron.

	Home £ s. d.
Hematite—	
East Coast Mixed Nos.	10 0 0
East Coast No. 1	10 2 6
West Coast Mixed Nos.	10 4 6
Scottish Mixed Nos.	10 10 0
Welsh Mixed Nos	11 0 0
Cleveland—	
No. 1	8 7 6
No. 3 foundry G.M.B.	8 0 0
No. 4 foundry	8 0 0
No. 4 forge	8 0 0
Basic	8 5 0
Derbyshire, Leices., and Notts—	
No. 4 forge	8 15 0
No. 3 foundry	9 0 0
No. 2 foundry	9 2 0
No. 1 foundry	9 4 0
Basic	9 2 6
Northamptonshire—	
No. 4 forge	8 5 0
No. 4 foundry	8 6 6
No. 3 foundry	8 7 6
No. 2 foundry	8 9 0
No. 1 foundry	8 11 0
Basic	8 17 0
South Staffordshire, Shropshire and Worcestershire—	
Part-mine forge	9 7 6
Part-mine foundry	9 10 0
Common Staffs.	8 5 0
All-mine forge	9 10 0
All-mine foundry	9 15 0
Warm-air forge	11 0 0
Warm-air foundry	11 10 0
Cold blast	14 0 0
Basic	9 2 6
Scottish—	
Foundry	9 15 0

NOTE.—The above prices are those fixed by the makers as a minimum for early delivery. In consequence of works being booked to capacity, makers are not committing themselves for later delivery.

Delivered in Manchester—	
*Derbyshire, No. 3	9 7 6
*Cleveland, No. 3	8 15 0
*Scottish, No. 3	10 12 6

* Merchant prices.

Delivered in Sheffield—	
East Coast hematite	10 8 6
Derbyshire basic	8 17 6
Lincolnshire basic	8 17 6
Do. No. 3 foundry	8 17 6
Do. forge	8 12 6

High-Speed Tool Steel.

	s. d.
Finished bars, 14 per cent. Tungsten	2 11
Finished bars, 18 per cent. Tungsten	3 6
Per lb. delivered buyers' works.	
Extras—	
Rounds and squares 3 in. to 8 in. inclusive	4d. per lb.
Rounds and squares under ½ in. to ¾ in.	3d. ,,
Flats under 1 in. by ¾ in. to ½ in. by ¾ in., and all sizes over four times 3 in width and over thickness	3d. ,,
Bevels of approved sizes and sections	6d. ,,
If in Coils	3d. ,,
Packing	4s. per cwt
Bars cut to length	10% extra
Scrap from High-Speed Tool Steel—Scrap pieces, 5d. Turnings and Swarf, 3d. Per lb. net, d/d steel-makers' works.	

Ferro-Alloys.

Ferro-Titanium—23/25%, Ti. carbonless, 1/6.
Ferro-Tungsten.—75/80%, 2/10.
Ferro-Molybdenum.—70/80%, Mo., 9/-.
Ferro-Vanadium.—35/40%, Va., 33/-.
Metallic-Manganese.—98/99%, carbonless, 3/9. (All per lb.).
Ferro-Phosphorus.—20/25%, P. £16 10 0
Ferro-Chrome.—4/6%, car., £45 0 0.
Ferro-Chrome.—6/8%, car., £45 0 0.
Ferro-Chrome.—8/10%, car., £45 0 0.
Ferro-Chrome—Specially refined, basis 60% Chr., max. 2% car., £100 0 0.
Ferro-Silicon.—45/50% Si., £21 0 0 d/d. at Sheffield Steelworks.
Ferro-Manganese.—80%, £27 loose, £28 0 0 packed. Export £27, according to destination. (All per ton.)

Copper.

	£ s. d.	£ s. d.
Standard cash	111 10 0	111 15 0
Three months	113 10 0	113 15 0
Electrolytic	118 0 0	121 0 0
Tough	117 0 0	119 0 0
Best selected	118 0 0	120 0 0
Sheets	154 0 0	—
India	153 0 0	154 0 0
American electrolytic spot	122 0 0	—
Do. Feb.	120 0 0	—
Official average price cash, Nov.	98 18 9	
Do. Three months, Nov.	100 4 7½	
Do. Settlement, Nov.	98 19 6	
Do. Electro, Nov.	113 7 0	
Do. B.S., Nov.	111 2 6	
Average spot price, copper, Nov.	98 18 1½	
Do. Electro, Nov.	111 6 0	

Tin.

	£ s. d.	£ s. d.
Cash	337 10 0	338 0 0
Three months	340 0 0	340 5 0
English	3 6 0 0	—
Bars	338 0 0	—
Refined	—	—
Straits	338 0 0	—
Australian	337 15 0	
Eastern	330 0 0	
Banca	337 15 0	
Official average price, cash, Nov.	283 13 7½	
Do. Three months, Nov.	284 18 10½	
Do. Settlement, Nov.	283 12 9	
Average spot price, Nov.	283 11 0	

Spelter.

	£ s. d.	£ s. d.
Ordinary	57 10 0	—
Remelted	49 0 0	50 0 0
Hard	39 0 0	40 0 0
Electro 99.9	61 0 0	—
English	59 0 0	59 10 0
India	48 0 0	50 0 0
Zinc dust	65 0 0	70 0 0
Do. English	—	—
Zinc ashes, per cent. 70%	—	14 0 0
Official average price, Nov.	46 17 3	
Average spot price, Nov.	46 12 0	

Lead.

Soft foreign (net)	45 0 0
English	46 10 0
Official average price, Nov.	34 16 0½
Average spot price, Nov.	34 14 7½

Antimony.

English regulus	47 10 0
Chinese	47 0 0
Crude	42 0 0
Ore	Nominal.

Aluminium.

Virgin Metal 98/99—. . 150 0 0 per ton.

Phosphor Bronze.

INGOTS.	Per ton.
Alloy No. I. or II.	—
III., IV., or V.	—
IV. or VII	—
VIII.	—
XI.	—
Cast Strips and Ingots	—
CASTINGS.	Per lb.
I. or II.	—
III., IV. or V.	—
IV. or VII.	—
VIII.	—
XI.	—
No. VII., Chill, Cast, Solid	—
,, Cored Bars	—

Delivery 2 Cwt. free to any town.
10 per cent. Phosphor Copper . . £50 above price of best selected copper.
15 per cent. Phosphor Copper . . £70 above price B.S.
Phosphor Tin (5 per cent.) . . £30 above price of English Ingots.
Phosphor-bronze prices supplied by CHARLES CLIFFORD AND SON, LIMITED, FAZELEY STREET MILLS, BIRMINGHAM.

*Chromium (Metallic).

98/99— purity, per lb. 6/6 — —

*Nickel.

In cubes, 98/99— purity per ton . . £215 0 0

Nickel Silver.

per lb.
Ingots for raising . . 1/6 - 1/11
Ingots for Spoons and Forks . . 1/6 - 1/11
,, rolled to spoon size . . 1/8 - 2/1

*Tungsten Metal Powder.

per lb.
98/98— purity 3/6

*Molybdenum Metal.

96/98— purity, per lb —

*Cobalt Metal.

97— purity, per lb. £ 0 10 0

Quicksilver.

75 lb. bottle £ 24 0 0

* Net, delivered Sheffield Works.

Scrap Iron and Steel.

Cleveland.	s. d.	s. d.
Steel scrap, heavy melting	—	—
Iron scrap cast (cupola metal)	—	—
(London f.o.b.).		
Heavy steel	130	0
Light ,,	90	0
Heavy cast	120	0

Steel Scrap.	Per ton £ s. d.
Without Analysis—	
Heavy steel melting scrap	7 5 0
Steel planings, turnings and borings	5 5 0
Steel planings, turnings and borings mixed with wrought-iron or other material	4 10 0
Other classes of steel scrap, whether or not mixed	6 15 0
F.o.r. or in barge at nearest siding or wharf.	
With Analysis—	
Heavy steel melting scrap not over 0.04 per cent. p. and s.	8 0 0
Heavy steel melting scrap not over 0.05 per cent. p. and s.	7 15 0

Wrought-Iron Scrap.

	£ s. d.
(1) (a) W.I. plates and sections, not less than ¾ in. thick, reasonably clear of rivets, flanged ends, etc., suitable for shearing; cable scrap and chain scrap not less than ½ in. dia.	8 7 6
(b) Heavy W.I. scrap not less than ¼ in. thick including horseshoes, rivets and bolts, and scrap therefrom	8 7 6
(c) W.I. scrap under ½ in. thick, and all W.I. scrap not included in classes 1, 2 and 3.	8 7 6
(2) Mixed W.I. scrap	6 17 6
(3) Wrought-iron planings, turnings and borings mixed with steel or other materials	4 12 6
(4) W.I. planings, turnings and borings	5 7 6

Cast-Iron Scrap.

	£ s. d.
Heavy ord., broken, between 1½ cwt. and 10 cwt. each	7 0 0
Heavy machinery, broken between 1½ cwt. and 10 cwt. each	7 5 0
Cold blast, broken, between 1½ cwt., and 10 cwt.	9 0 0
Ingot mould, unbroken	8 5 0
Do. broken, between 5 cwt. and 2 tons each	8 10 0
Do. between 1½ cwt. and 5 cwt. each	8 15 0
Railway chairs, whole or broken for remelting	7 5 0
Heavy lumps, not exceeding 2 tons each	6 17 6
Light	6 10 0
Burnt, broken ready for cupola	5 15 0
Burnt fire bars	6 5 0
Turnings and borings, for iron and steel makers	5 10 0

Old Metal.

London—	£ s. d.
Copper (clean)	80 0 0
Brass (clean)	52 0 0
Lead (less usual draft)	32 10 0
Tea lead	31 0 0
Zinc	32 0 0
New aluminium cuttings	100 0 0
Braziery copper	72 0 0
Gunmetal	75 0 0
Hollow pewter	200 0 0
Shaped black pewter	140 0 0
(Above all d.d merchant's yard).	

Metallurgical Coke.

Durham and Northumberland—	£ s. d.
Blast furnace	2 8 0
Foundry	2 13 0
Lancs., Staffs., Yorks, Notts., Derbyshire, Lincolnshire and Midland Counties—	
Blast furnace	2 10 6
Foundry	3 6 0

F.o.t. at ovens.